The UNESCO Courier

A window open on the world

June 1971 (24th year) - Price: 50' cents

COOL CAT
COURTESY OF
MODERN
CHEMISTRY

XUM

Photo G.F.N. - Museo Nazionale, Chieti, Italy

Captain from Capestrano

TREASURES
OF
WORLD ART

56 *Italy*

Standing over two metres (six and a half ft.) high, this effigy of a Samnite leader was unearthed at Capestrano, an Abruzzi township on the eastern slopes of the Apennines in Italy (photo shows bust). The Samnites, one of the ancient Italic peoples, came from the East and after settling in the mountains at the centre of the peninsula, harassed Rome and Latium until the 3rd century B.C. Carved in stone and dating from the 6th century B.C., the statue retains traces of red colouring. It was recovered in 1934 from a burial ground containing 33 tombs. The figure's broad-brimmed headgear, axe, sword and dagger are the attributes of a chieftain; the highly stylized face suggests, and may well be, a mask. The inscription in Oscan characters on the pillars flanking the statue are as yet undeciphered, and may record the name of this "Captain from Capestrano."

The UNESCO Courier

JUNE 1971
24TH YEAR

PUBLISHED IN 13 EDITIONS

English
French
Spanish
Russian
German
Arabic
U.S.A.
Japanese
Italian
Hindi
Tamil
Hebrew
Persian

Published monthly by UNESCO

The United Nations
Educational, Scientific
and Cultural Organization

Sales and Distribution Offices
Unesco, Place de Fontenoy, Paris-7•

Annual subscription (any edition) : $ 5.00
Single copies : 50 cents

The **UNESCO COURIER** is published monthly, except in August and September when it is bi-monthly (11 issues a year) in English, French, Spanish, Russian, German, Arabic, Japanese, Italian, Hindi, Tamil, Hebrew and Persian. Sales and distribution: UNESCO Publications Center, U. S. A., P. O. Box 433, New York, N. Y.,10016, MU 6-4707 (sole distributors of the U.S.A. edition).

Individual articles and photographs not copyrighted may be reprinted providing the credit line reads "Reprinted from the **UNESCO COURIER**" plus date of issue, and three voucher copies are sent to the editor. Signed articles reprinted must bear author's name. Non-copyright photos will be supplied on request. Unsolicited manuscripts cannot be returned unless accompanied by an international reply coupon covering postage. Signed articles express the opinions of the authors and do not necessarily represent the opinions of UNESCO or those of the editors of the **UNESCO COURIER.**

The Unesco Courier is indexed monthly in the Readers' Guide to Periodical Literature and in Current Contents - Education, Philadelphia.

★

Editorial Offices
Unesco, Place de Fontenoy, Paris 7•, France

Editor-in-Chief
Sandy Koffler

Assistant Editor-in-Chief
René Caloz

Assistant to the Editor-in-Chief
Lucio Attinelli

Managing Editors
English Edition : Ronald Fenton (Paris)
French Edition : Jane Albert Hesse (Paris)
Spanish Edition : Francisco Fernández-Santos (Paris)
Russian Edition : Georgi Stetsenko (Paris)
German Edition : Hans Rieben (Berne)
Arabic Edition : Abdel Moneim El Sawi (Cairo)
Japanese Edition : Hitoshi Taniguchi (Tokyo)
Italian Edition : Maria Remiddi (Rome)
Hindi Edition : Kartar Singh Duggal (Delhi)
Tamil Edition : N.D. Sundaravadivelu (Madras)
Hebrew Edition : Alexander Peli (Jerusalem)
Persian Edition : Fereydoun Ardalan (Teheran)

Assistant Editors
English Edition: Howard Brabyn
French Edition: Nino Frank
Spanish Edition: Jorge Enrique Adoum

Photo Editor : Olga Rödel

Layout and Design : Robert Jacquemin

All correspondence should be addressed to the Editor-in-Chief in Paris

N° 6 - 1971 MC 71-2-267 A

Page	
4	**THE MAGIC OF MODERN CHEMISTRY** *By Gene Gregory* **(1) TOWARDS A NEW QUALITY OF LIFE**
8	**(2) THE NEW CHEMISTRY OF FOOD**
12	**(3) THE EVER-EXPANDING ARMAMENTARIUM OF DRUGS**
15	**(4) THE 10,000 METAMORPHOSES OF PLASTICS**
18	**ONE DROP OF GLUE DOES THE TRICK**
21	**WHERE ARE THE SNOWS OF YESTERYEAR?**
24	**THAT CHART ON THE LABORATORY WALL** Mendeleyev's Periodic Table *By Ghenrikh Teterin and Claire Terlon*
28	**SCIENCE'S HUNT FOR THE MISSING LINKS OF NATURE** *By Vitali Goldanski*
33	**LETTERS TO THE EDITOR**
34	**UNESCO NEWSROOM**
2	**TREASURES OF WORLD ART** Captain from Capestrano (Italy)

Photo © Life

Cover

Cover photo is a striking illustration of the revolution wrought by modern chemistry. Sitting comfortably over a 4,000 degree Fahrenheit (2,200 C.) flame, this kitten is protected by a slab of silicone, a new transparent rubbery material which transmits almost no heat, even at temperatures four times hotter than the melting point of steel. By re-arranging and linking up synthetic giant molecules, called polymers, modern chemistry is today capable of creating virtually any type of new material (article starting on page 4).

XUM

PUNCH PROOF PLASTIC. Even a violent blow cannot break this thin plastic film. One of the versatile new materials created by modern chemical technology, it can be used in different forms for anything from household equipment and motor-car parts to containers for oil and liquid chemicals. Today thousands of lightweight, fireproof, rigid, flexible, tough or gossamer-thin products are being produced by the plastics industry.

THE MAGIC OF MODERN CHEMISTRY

by Gene Gregory

1 Towards a new quality of life

CHEMISTRY, like all science and technology, has an ambivalent status in society today. On the one hand, it is acknowledged that it has enabled man to survive and flourish on our overcrowded planet. Men and women in advanced industrial nations are using chemistry to defend and extend the material benefits that derive from increasing human predominance over the rest of nature. At the same time, the people of less developed countries are striving after the products of modern chemistry that can make their lives more healthy, comfortable and productive.

And yet, there are many who decry chemistry as the cause of undesirable qualities of modern life. In an explosion of irrational compulsion to condemn those very intellectual, scientific and technological endeavours that have enabled modern man to rise from savagery, chemistry has been blamed for all manner of treachery against the quality of life.

But denial of the humane value of scientific knowledge and obstacles to its wise use for the benefit of mankind are by no means unique to our times. History is replete with records of opposition to scientific inquiry and the introduction of new technologies that challenged old beliefs, threatened established institutions and changed patterns of life.

Antoine Lavoisier, Nicolas Leblanc and Joseph Priestley—who along with Henry Cavendish were the founders of modern chemistry—are classic examples of scientists who were opposed and suppressed by irrational prejudice.

Fortunately, nowadays these men are granted their due credit for having opened the doors to a whole new field of science which has since led to the development of one of the key industries of our technological world—making products used in practically every aspect of life.

Still, as we enter the post-industrial, or technetronic, era, we hear politicians deploring, much as did those leaders of the French Revolution who sent Lavoisier to the guillotine, that "today we stand helpless before the onslaught of science."

Similarly, there are those intellectual Luddites who would destroy the very edifice of human progress by forcing scientists to answer the question of what impact their achievements will have upon the quality of life.

While it would seem to be self-evident that the Swiss inventor of LSD could no more predict the abuse others would make of his breakthrough in the development of psycho-active drugs than Henry Ford could have foreseen, or been held accountable for the death and maiming of countless ten of thousands of people in automobile accidents, the nature and the motives of the scientist, hardly so well understood as those of the inventor, are called in question. The scientist, rather than the malefactor, is held responsible.

Here, indeed, may be the root of the problem. Because the layman does not understand the mysteries of complex science and has seemingly less control over its products than he has over the motor car, fear and suspicion of science have replaced the curiosity and active interest in scientific advancement that was the hallmark of the two centuries of phenomenal progress between 1750 and 1950.

But because of the vital role played

CONTINUED PAGE 6

GENE GREGORY, *is a special research writer for the "Unesco Courier" on world problems of science and technology (March 1969 issue: "New Food Revolution"; March 1970: "Spin-off: the Fruit of Space Research"). A chemical engineer and industrial consultant, he was formerly editor-in-chief of the "Weekly Tribune", in Geneva, Switzerland, and a member of the editorial board of "Asia Magazine", Hong Kong. He spent many years in South-East Asia where he was a foreign correspondent for Reuters Agency and held several editorial. posts. The four-part article published here is a special inquiry he has carried out for the "Unesco Courier" into the revolutionary applications of chemical technology.*

Photo © Dupont de Nemours, Paris

by science in modern society, its rejection in some quarters as a means for improving the quality of life could have especially serious social consequences. Clearly, if the 7,000 million people who will inhabit the globe in the year 2000 A.D. are to be adequately fed, clothed, housed, educated, informed, transported and purposefully employed—in short, if they are to be masters of their environment rather than its slaves—it will be only through the instrumentality of applied science and that form of human activity we know as industry.

This increasing power to change the physical world around us, to fulfil human needs and aspirations, is due in large part to the science of chemistry and the industry which translates its findings into new and better products.

We can divide the needs of human beings in society into four grades of urgency to each of which chemistry makes a critical and frequently central contribution.

First of all, there are the primary biological needs of food, shelter, health and recreation. Then there are the means for providing these requirements: productive industry, communications and transportation. Social and economic structures are then necessary to maintain balance and provide the necessary ambient conditions for human fulfilment. Finally, man takes cognizance of himself and at the same time expresses himself through what may be called his culture: in manners, art and intellectual endeavour.

Quite obviously, it is in meeting the first two sets of human needs, those basic physiological needs which sustain life and society, that chemistry plays the greatest part. But, along with other sciences, chemistry is also an agent of social and economic change; and both as an operative science and by the image it presents, chemistry is an essential factor in the manners and cultural activity of men.

At the beginning of the 1970s, the average citizen of an industrially advanced country was using from 300 to 500 chemical products in his everyday life: about 60 in his clothing, some 200 in his home, office and automobile; another 50 in medicines to safeguard his health, and still another 50 or more at every stage of producing and preparing the food he consumes. There is hardly an activity of modern man that does not, in some way, use some of the nearly one million chemicals that exist today.

THE list continues to grow every year. In the U.S. alone, more than 500 totally new chemicals are introduced commercially each year, while in the city of Basel alone, 3,500 scientists spend almost $150 million annually in research and development of medicines, dyestuffs, plastics, agricultural chemicals, cosmetics and a wide variety of other products all destined to meet human needs in 1985 and in 2000 A.D.

If half of today's chemical production consists of products which were not in existence ten years ago, by 1985 a whole new generation of chemical products will have been developed and before the turn of the century still another generation will have made its appearance.

While in the 1960s in most advanced countries the chemical industry was fourth in rank after petroleum, primary metals and transportation equipment, by 1985 it will have surpassed primary metals, and very possibly it will be the leading industry along with electronics in the year 2000. Here are just a few of the reasons why.

If we are to produce enough food in 1985 to feed the world, the United Nations Food and Agriculture Organization estimates that in developing countries alone consumption of fertilizers and crop protection chemicals must be at about 12 times the 1962 rate; and by the year 2000 consumption will have increased another eight to ten times over the 1985 level.

Parallel to the demands for an increased supply of foodstuffs for the world's population there will be a rise in clothing needs which, as prosperity increases, is expected to be disproportionate to the increased consumption of food products. However, since for climatic and regional reasons the production of wool and cotton has already reached its maximum level, clothing needs must be met almost entirely from increases in production of cellulose and fully synthetic fibres.

Annual world production of cellulose fibres, now running at a level of 3.5 million metric tons, will grow to more than seven million metric tons by the turn of the millenium. Even more remarkable, the production of synthetic fibres is expected to grow from a current three million metric tons to an estimated 25 million metric tons by the year 2000.

During the same period, the value of plastics output for consumer, construction and industrial applications will far outstrip that of steel production, as the introduction of a wide variety of composite materials combine, for instance, the great strength of pure crystals of metals with the elasticity or other qualities of organic chemicals.

This incipient "materials revolution" will make possible an enormous number of new products, new satisfactions and new markets; it will advance man one more step along the road of independence from nature and control over his environment to the adequate satisfaction of primary human needs.

Photo © Rhône-Poulenc Textiles, Paris

Photo Georg Gerster © Rapho, Paris

The 100-storey building (above) dwarfs skyscrapers around it on the Chicago shore overlooking Lake Michigan. Using aluminium backed with plastic foam as an insulator, Chicago architects were able to design the 100-storey building at a cost no greater than that of a conventional 45-storey building. Specially designed plastics have opened new horizons for more economical housing and building construction.

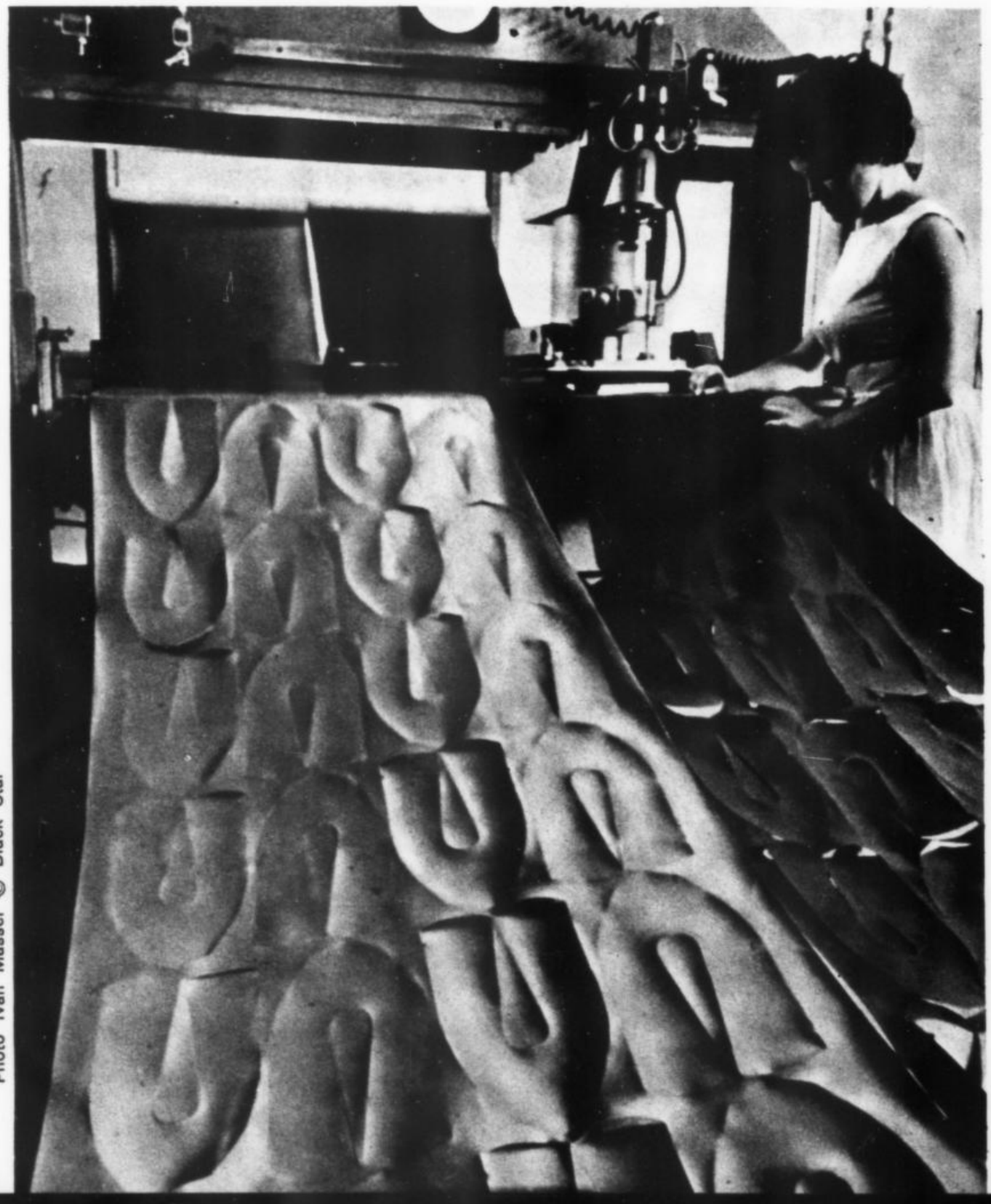


Photo Ivan Masser © Black Star

ROLLING OUT THE ROAD AND SHOES TO GO WITH IT

Why not? But who would have believed it? Far left, a road (near Poitiers, France) is being rolled out on to the bare earth. Made of synthetic fibres it comes, like oversized linoleum, in giant rolls. Tar macadam is then poured over it and Bob's your uncle—the road is finished. Left, sheets of synthetic shoes roll from a press after being stamped with patterns that will be fashioned into shoe uppers. The material is water repellent and to duplicate leather's "breathability", it has more than a million pores per square inch.

2

- The new chemistry of food
- Debunking some pesticide and fertilizer myths
- Miracle proteins for wheat and corn

IF you polled the earth's population, there would be no question about the most critical problem in the world today; clearly, it is how do we get enough of the right food to eat. While it is easy to overdramatize the tragic character of the world's present food situation, it is also possible to assess the needs of the present population and any future world population.

This ability to comprehend, measure and predict with some degree of probable accuracy the food needs of humanity, as was recently undertaken in the FAO Provisional Indicative World Plan, makes it possible within the scope of available technology to construct a system of production and distribution in which those needs would find satisfaction.

To be sure, taken at face value, food statistics can be brutal. Food supply is at present adequate only in 30 industrialized nations in the temperate Northern area, where 900 million people live. But in 70 other less developed countries, the diets of 1,900 million people are nutritionally inadequate, chronic malnutrition is widespread, and thousands still die from hunger every year. Moreover, before these countries can possibly make much progress economically or socially, they must have better diets to sustain the necessary effort.

Until the latter years of the 1960s, population in all developing countries was growing faster than the increase in food production. If this were to continue, alarmists claimed, we would be confronted with world famine by 1975. Then came the "green revolution", with a veritable takeoff in wheat production in Mexico and Pakistan, followed by sharp increases in rice production in south-east Asia.

Suddenly, what scientists instinctively, if not empirically, knew all along began gaining some degree of popular credence: we can, after all, feed the present and foreseeable population of the earth. New technology has brought new hope to developing countries that there will be enough for all to eat *in this generation.*

Once improved varieties of cereals had been developed, much of what had to be done was the task of chemicals plus the proper increments of water applied at the right time and places.

In 1840 the pioneering German agrichemist Justus von Liebig formulated his basic theory on plant nutrition: any plant requires a certain amount of nitrogen, phosphorus and potassium in a soluble form in order to secure its growth, and these three essential elements can neither be replaced by others nor are they interchangeable.

While the scientific work of Liebig had an immediate effect on the promotion of the phosphate and potassium industries, the amount of soluble nitrogen compounds from natural deposits turned out to be insufficient and all efforts to convert the nitrogen content of air into suitable compounds had failed.

Then came the dramatic appeal in 1898 of Sir William Crookes, in his now-famous lecture at Bristol, to chemists all over the world to develop a method for the fixation of the nitrogen content of air. He made it clear that the spectre of general famine would not be banished as long as there remained an inadequate supply of nitrogenous mineral fertilizers and that this supply could not come from the technologies and production facilities then available.

Thanks to the work of Fritz Haber and Carl Bosch, who in 1908 introduced the technique of hydrogenation

Photo Anthony Howarth © Black Star - Rapho, Paris

under high pressure of the nitrogen contained in air to form ammonia, the amount of nitrogen production in the world became the decisive factor for the increased volume of food production, helped by mineral fertilizers.

Over the last hundred years, by the gradual application of new soil treatment technology, Germany has increased yield per hectare of both wheat and potatoes over four times. But the potential improvement from fertilizers is far from being fully developed even in the most advanced countries. Complete fertilizers which contain in one application all the elements for plant growth in the correct combination are being developed.

Despite the advances in fertilizer technology over the past century, there still persists among some seemingly knowledgeable people the extraordinarily erroneous notion that any further additions to the world's area of cultivated land must be very limited. Even in the very cautious view of the late Sir Dudley Stamp, mid-twentieth century man was working only about one-third of the world's potential agricultural land.

With intensive use of fertilizers and other available improved techniques of cultivation, as practised in the Netherlands and Japan, the potential agricultural area of the world could provide food at maximum consumption standards for 35,000 million people, or over ten times the world's present population—without allowing for further improvements in technology or further increases in food from the sea.

Fertilizer use is on the threshold of making an important breakthrough in forestry and fisheries, conserving and developing these resources to the better long-run service of humanity in an evolving balance of man and nature.

In Bulgaria, systematic application of fertilizers in the controlled atmosphere of large 50-hectare glassed-in greenhouse farms, has enabled that country to emerge as one of Western Europe's primary year-around suppliers of vegetables.

In the early 1960s, Carl N. Hodges, a graduate student from the University of Arizona, developed a special research facility at Puerto Penasco, Mexico. He did so by combining fresh water, produced from the sea by a new technology in solar desalination, and carbon dioxide, from diesel engines, with proper inputs of soil nutrients. In this facility, housed in controlled-environment greenhouses of air-inflated polyethylene film, 160 varieties of 18 vegetables and fruits have been grown.

Results achieved by this synergistic combination of products of modern chemistry, which produced higher yields of at least one variety of each fruit and vegetable tested than normally obtain in field crops, had immediate revolutionary implications for desert areas of the world with access to ocean or brackish ground water.

The first large-scale "portable" farm using the results of a new University of Arizona Environmental Research Laboratory under Hodges' supervision was, understandably enough, developed for the Arabian Gulf Sheikhdom of Abu Dhabi about 500 miles south of Kuwait. Production cost of vegetables grown, allowing for a 10-year amortization cost of the installation, is running about 20 cents (US) a pound, compared with an average $1.50 or more a pound at retail for produce shipped from Kuwait.

Already, half of the world's population is fed by the extra yield that is produced by the use of commercial fertilizers, now being consumed at the rate of 27 million metric tons annually. To be able to feed properly the population expected by the year 2000, fully utilizing new agrichemistry technology as it develops, it will be necessary to increase world production to 90-95 million metric tons a year.

With the use of natural gas and mineral oil fractions as the raw material source for the needed hydrogen, the necessary fertilizer factories could, in principle, be erected directly in the various markets throughout the world. With the present level of technology this will require capital expenditures of $33,000 million at 1970 prices to meet the needs up to the end of the century.

But this is only the beginning of chemistry's contribution to the potentially abundant food supplies of the future. As man strives to produce more food for 60 million new mouths each year, he creates field conditions that encourage the zooming multiplication of more than 10,000 species of insects who compete for a food supply not yet adequate to assure a minimum diet for all.

It has been said, perhaps with some exaggeration, that we humans can feed only on what is left over for us by pests. Somewhat more precisely, expert estimates made in the 1960s by six different authorities put total food losses from pests at between $30,000 and $60,000 million, with a leaning toward the higher figure.

Some calculations have put the losses due to bugs and weeds even higher: a minimum of $70,000 million is currently lost, with insects accounting for losses of approximately 12 per cent, plant diseases for 12 per cent,

CONTINUED NEXT PAGE

Photo General Electric, Schenectady, New York

Microbes that devour garbage and convert it into protein-rich animal fodder could help relieve the world's growing refuse disposal problem. Right, Dr. W. Dexter Bellamy, a biochemist at one of New York's large research and development centres, has identified bacteria that can digest cellulose and related chemical compounds which together account for most of the solid wastes produced by large cities. Fertilizers are the key to making poor soils produce economic crop yields, and slow-acting fertilizers, now coming on the market, avoid over-dosing and require only one application during the entire growth cycle. New farming techniques combined with modern chemical fertilizers offer hope to developing countries of providing enough to eat for all within this generation. Left, graceful crop patterns of a hillside farm in central Africa.

XUM

DDT from A to Z

Photo Jean Manuel- FAO

LOCUST LEFTOVERS. It has been said that humans feed on what is left over by the pests, and a single locust with its powerful jaws devours its own weight in food each day. A swarm of locusts will eat between 30,000 and 100,000 tons of vegetation in twenty-four hours. Despite the current controversy about DDT and other chemical pesticides, it is still an open question as to whether they are as harmful as many people think. A top official of the Food and Agriculture Organization stated recently that " millions would starve without chemical defences against insects ", and the World Health Organization has defended the use of DDT as indispensable at the present time to combat malaria-bearing mosquitoes.

and weeds for 10 per cent of potential production. And these losses are suffered even with the widespread use of pesticidal tools now available.

Dr. Herrel DeGraffe, Cornell University nutritionist, estimates that if we were to eliminate chemicals in food production about one-third of the world's people would not eat at all. "Millions would starve without chemical defences against insects," a top ranking FAO official said recently.

Even in the United States, where food surpluses have bugged economists and policy-makers for over a quarter of a century, without chemical pesticides, food supply would have to be rationed; housewives would have to queue to buy inferior foods, and they would pay 25 per cent more for them.

Although fighting against tremendous odds, man has been resourceful enough to eliminate weeds that compete with food plants for nourishment from the soil and to fight off persistent hordes of insects. Throughout the ages he has sought new weapons to increase his advantage over insects in the competition for food.

Gradually, with the advent of an industry specialized in the production of pesticides, magic spells, waving fans and flails wielded by weary slaves, the only weapons early man could command in his war with bugs, were replaced by over 200 efficient and safe chemical compounds which have now seemingly tipped the scales of battle in favour of homo sapiens.

As a result, in Japan, where pesticides usage per hectare of crop is more than five times that of Europe and North America, yields per hectare are almost twice those of Europe and more than double those of the U.S. Loss from insect damage to rice is estimated to average only 1.5 per cent as a result of a continuing vigorous pest control campaign, where damage inflicted by the stem borer caused losses of 50-60 per cent in South Japan in five years out of ten up to thirty years ago.

SIMILAR advances in disease control in Japanese rice crops have resulted from the general use of fungicides, particularly for seed treatment. These chemical defences, along with improved seeds, have transformed Japan from a chronic major food deficit area to a country of food surpluses in the short span of 25 years, at a time when the exodus from rural areas to the cities reduced agricultural man-

power from 47 per cent to 19 per cent of the labour force.

While rice production was a moderate 3.63 tons per hectare before World War II, it rose to 5.02 tons per hectare in the mid-1970s, compared with a meagre 1.4 tons per hectare output in India and 1.3 tons per hectare in the Philippines—or about the level of output already attained in Japan by the 16th century.

Despite these low yields, statistics indicate that the use of pesticides to eliminate storage losses alone could go far toward rendering India self-sufficient in cereal grains at current rates of consumption. Losses of main cereals during storage exceeded 5 million tons in India during 1962-64, or roughly a million tons higher than the country's entire food-grain imports in 1962.

Despite the urgent need for more effective protection of pre- and post-harvest losses from pests, diseases and weeds, and the demonstrable profitability of efficient crop protection operations, farmers in most countries often still regard such damage as something to be endured but not cured, in the same manner as floods, droughts, hurricanes and other natural hazards.

AT the same time, some gifted polemicists, with an emotional, romantic and mystical bent, have effectively managed to persuade many people, including some public officials, that pesticides—especially DDT—are dangerous and should be banned.

Contrary to many reports, no-one has yet been harmed in any way by residues of crop protection products. All these substances, if taken in sufficient dosages, can be lethal. But only a few pesticidal chemicals ever reach man's body, and then only in minute traces—except by accident, suicide or murder.

Yet panic caused by current widespread denunciation of DDT and other pesticides has resulted in premature measures to restrict its use, with resultant reversals of results obtained by expensive campaigns to conquer malaria and eradicate other pests.

On the whole, despite increasing efforts to develop suitable biological methods of control, FAO and WHO warn that there are as yet few alternatives to destroying pests by chemical means. FAO plant protection experts say specifically that "in the developed world the great DDT controversy is largely an irrelevancy. It (DDT) is going out because so many insect pests are developing resistance to it and because better and more refined control methods are becoming available.

"In the developing world the situation is more difficult. There is no other pesticide available that is still effective against so many insects, that is non-toxic to man and that is so cheap. The developing world simply cannot abandon DDT at present although it will in the future begin to benefit from the new methods of pest control being developed in the more technologically advanced countries."

Any major change in the established agro-ecosystem tends to disturb the complex crop-pest equilibrium, causing minor or relatively stable incidences of pest and diseases to erupt suddenly as major outbreaks. Many of the measures taken during the coming years to improve agricultural productivity in developing countries will inevitably alter the environment, often creating more favourable conditions for pests. Crop protection, in all its aspects, therefore, will assume rapidly increasing importance in developing countries during the next two decades.

Fortunately, there are signs of rapidly changing attitudes toward pest control amongst farmers. Imports of pesticides in 1965 by India and Taiwan were three times the 1961-63 average, while imports of the Republic of Korea, Pakistan and Thailand doubled in the same period. Even more dramatic increases have been reported since 1966 from South Asia, where the gross area covered by plant protection measures had increased five times in India in the four years 1965-1969 and pesticides imports by Ceylon jumped 175 per cent in 1967 alone. For all developing countries, FAO estimates pesticide requirements in 1985 at $2,000 million per year, compared with consumption of only $180 million in 1962.

New technology will alter this estimate over time, however. Insecticides derived from phosphoric acid esters, already available commercially under various brand names, will gain in importance during the next few decades, whereas use of chlorinated hydrocarbons such as DDT will be progressively receding.

At the same time, the increasing use of selective herbicides, one of the most striking post-war phenomena in crop protection, is to be expected in developing countries in coming years. The net efficiency of these herbicides is considerable, achieving yield increases of up to 30 per cent by their timely use in temperate zones, and even over 50 per cent in some tropical countries.

Equally important, the introduction of the so-called "systemic" chemicals —a new generation of non-persistent pesticides which enter the vascular system of the plant, spread their protection throughout, and then metabolize into harmless degradation products—is expected to save Britain, for instance, some £40-50 million worth of cereal grains per year by eliminating powdery mildew—a disease that regularly causes losses of up to 15 per cent of grain yields in the U.K.

While chemistry is to play the major role in increasing agricultural output during the next three decades, a tremendous increase in protein value of world cereal supplies can be achieved within a few years by the use of synthetic amino acid additives. Methods have been developed for enriching wheat with lysine, corn and sorghum with lysine and tryptophan, and legume-based foods with methionine—either before milling or by introduction into flours and meals.

Increases of more than 50 per cent in wheat protein value can be achieved by the addition of no more than 0.4 per cent lysine, while appropriate additions of lysine and tryptophan to corn approximately doubles the utilizable protein. Major food-producing countries have found soybean meal fortified with methionine most economical as a major protein source for poultry and swine rations. Similarly, developing countries in which legumes are used on a large scale for animal feeding, as well as for human consumption, can boost protein availability sharply at relatively low costs by incremental applications of these amino acid additives.

All essential amino acids are now produced in chemically pure form, although for some production costs are still extremely high. As costs decrease with their increasing use in fortification of natural foods and synthetic processes are developed further, it should be feasible before the end of the century to combine these into palatable synthetic foods fully satisfying the protein requirements of man.

BUT chemistry has developed still other means of providing animals, fowl and fish with industrially produced proteins to supplement their normal diet, increasing the quality and yield of food from these sources. Yeast products derived from mineral oil, while as yet unsuitable for human nutrition, can be used as components in the manufacture of concentrated animal and poultry feeds.

Experimental efforts by more than a score of multinational petroleum companies to use petroleums as a feedstock for yeast production have established the technical feasibility. One of the companies, British Petroleum, brought a plant on stream in 1970 which is expected to produce 16,000 tons of protein a year. The Soviet Union, chronically short of feedstuffs, is also producing single-cell protein (SCP) of feed quality on a limited scale, while Japan is moving rapidly toward large-scale commercial production—expecting to produce more than 300,000 tons yearly by the end of 1971.

Should this technology become as firmly established as those investing huge sums in its development believe

CONTINUED NEXT PAGE

it will, it is bound to have far-reaching implications for conventional animal-husbandry and for agriculture as well. While presently conceived as a feed supplement, it may come to compete with grain feeds in animal diet and even to alter human eating habits as well.

How ironic that would be: photosynthesis, occurring eons ago, produced plant life that was eventually converted into petroleum; now petroleum chemistry has made it possible for that solar energy to compete with products of photosynthesis occurring on our farms in the production of food for man today.

But this irony deserves more than passing observation. While it may be hard to believe in an age marked by hysteria about the prospects of world-wide famine, just as the process of industrialization will transform the economies of all developing countries, food surpluses—rather than food shortages—are likely to be the major problem of the future.

In both Western Europe and North America food surpluses, even in this age of relative global food deficiency, challenge the distribution capabilities of business and governments alike. How much more complex the problem will be if magnified on a global scale.

Here, too, modern chemistry has a critical role to play. Sterilization, refrigeration and cryogenization, colouring, flavouring and packaging all depend upon the availability of new and improved chemical products. Applied chemistry also promises new materials for construction and power sources that promise to facilitate the task of storage and transport of food under conditions and at costs which will assure its availability to consumers in all countries.

If, then, the industrial revolution can be said to be little more than a massive breakthrough in agriculture, chemistry takes primacy of place as a force for change. And if the benefits of this revolution are to be made available to those countries still relatively untouched by this progress, in the remaining years of this century, organic chemistry, biochemistry and microbiology—the scientific triumvirate which powers the modern chemical industry—are destined to play a major role.

Only the radical progress in these fields can explain the dramatic turnaround in prospects for world agriculture in the last five years.

In a host of countries throughout the world the agricultural revolution suddenly shifted to the takeoff stage. This was a dual revolution; a revolution of new techniques at critical stages of the food-raising and preserving process, and a revolution in the sense that known techniques long held back by a variety of political and social barriers are now being made available to the less developed parts of the world.

3 The ever-expanding armamentarium of drugs

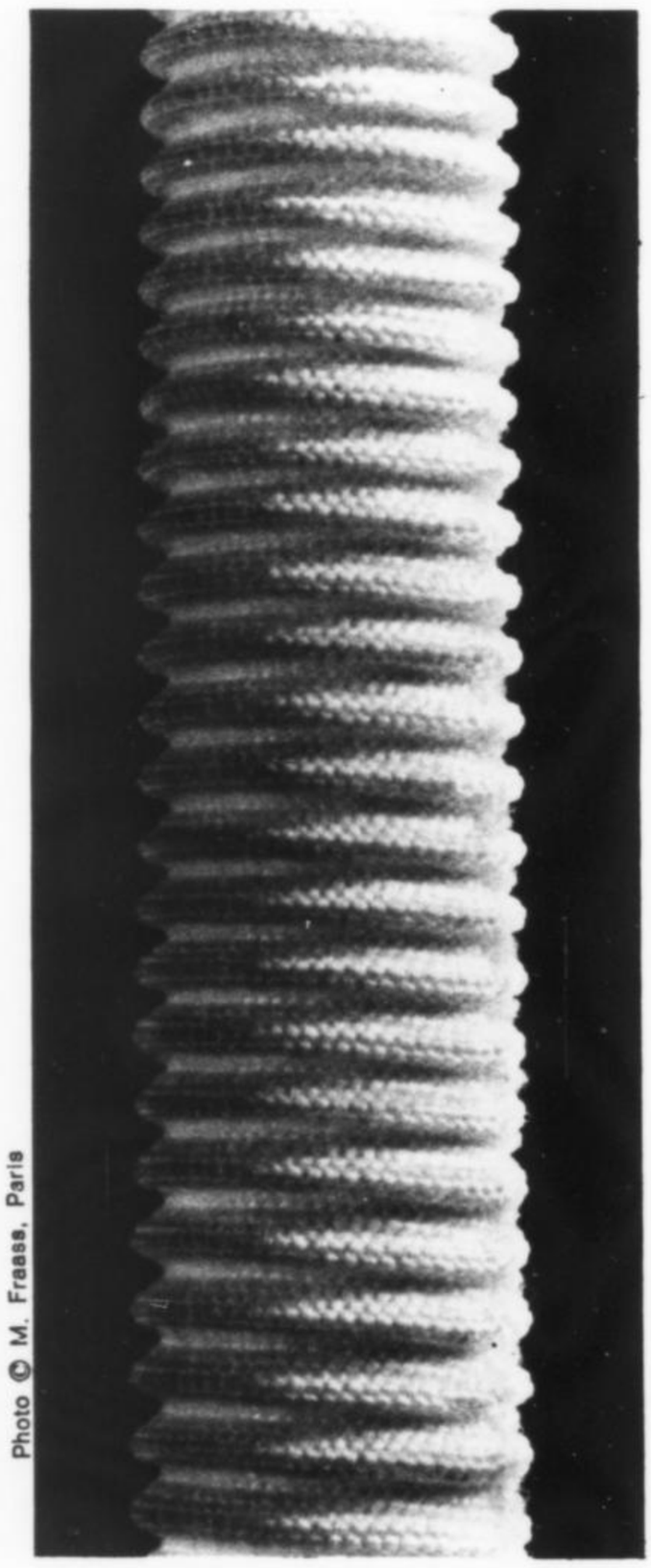


Photo © M. Fraass, Paris

SPARE INNER TUBE. Part of a plastic artery, magnified about three times, which is used by surgeons to replace defective human arteries. The applications of modern discoveries in chemistry have already gone a long way towards making "spare parts surgery" on a large scale a practical possibility.

A revolution, in which chemistry plays a role equally as important as in agriculture, is underway in modern medicine and public health. Synthetic detergents have vastly improved sanitation, and debilitating. and lethal diseases have been eliminated by the eradication of carrier insects through widespread and systematic application of insecticides. A vast array of preventive and therapeutic medicines have conspired with improved diets and better shelter to reduce infant mortality and increase average life expectancy to 67 years for men and 74 years for women. By 1985, the figures are expected to reach 80 for both males and females of the species.

Much of this success derives from modern medicine and its ever-expanding armamentarium of drugs, provided very largely by the organic chemists, biochemists, nuclear chemists and microbiologists working in the research-based pharmaceutical industry.

Attempts to use drugs to alleviate disease are as old as the history of man. The Chinese, for instance, developed an elaborate pharmacology using a wide variety of remedies found in nature.

But the concept of systematic laboratory investigation of drug action did not arise until the 1850s when the striking development of the German chemical industry prompted Oswald Schniederberg to study the damage brought about in living organisms by chemically active substances. Only after 1930 did the pharmaceutical industry reach the takeoff stage, when a powerful array of new therapeutic agents was developed in a surprisingly short time.

Already we tend to take for granted the improved quality of life that has evolved from the fact that man can expect longer life, to spend less of his life in illness or in pain, and to have a steady flow of important new drugs at prices that are within his reach. During the twenty year period, 1944-64, in the U.S. alone, some 3,250,000 people survived who would have died if the 1944 death rate had prevailed throughout the two decades.

XUM

But the discovery and development of the sulfonamides, antibiotics, and other anti-infective drugs have dramatically reduced death rates from a number of infectious diseases throughout the world.

Thanks largely to drugs, remarkable changes have taken place in the treatment of tuberculosis: with the use of streptomycin, a 49 per cent decline in death from this long-time major killer was attained, and within a year after the introduction of isoniasid, the death rate had declined by 86 per cent. These are but a few examples of the rapid improvement in life through chemistry in the last three to four decades.

Many pharmaceutical products have marked effects on the quality of life without effecting longevity, however. Non-addictive pain killers, are one example. Reliable oral contraceptive therapy, which makes intelligent family planning possible, is another. Tranquillizers and other drugs that influence the central nervous system have made an important contribution to the control of mental diseases and the restoration of mental patients to normal life.

Prospects for further advancements in biochemical pharmaceuticals and their contribution to our health, vigour and longevity during the next thirty years are exciting, and in psychoactive drugs and genetics both attractive and a little frightening.

As people live longer, medicine for the aging will claim more attention. There will be a decrease in the debilitating effects of senility, heart disease and arthritis. The development of new synthetic organ and tissue substitutes will serve to prolong life where only parts of the body are threatened; and techniques of organ transplantation with the development of improved immuno-suppressive drugs will be further perfected.

And, not least, scientists may determine in what sense death is an inevitable biological necessity, or how far it is the result of a series of pathological accidents, each one of which can be separately eluded or corrected by changes in dietary habits or the appli-

CONTINUED NEXT PAGE

Photos John Zimmerman © Life

CANARY IN DAVY JONES'S LOCKER

Dry and chirpy at the bottom of a fish tank, the canary above is enclosed in a casing of silicone film so fine that, though watertight, it allows oxygen to pass through from the water surrounding it. In effect, this artificial membrane acts in the same way as the gills of a fish. Left, the membrane is formed of two sheets of silicone film, laminated together, with a combined thickness of one thousandth of an inch. Silicone suits could one day make it possible for divers to dispense with air tanks; silicone tents, which let through oxygen faster than the other gases in the atmosphere, could be used in hospitals as oxygen tents supplying oxygen-enriched air to patients with no mechanical aid.

XUM

The most exciting innovation since antibiotics

cation of proper chemotherapeutic agents.

New understanding of the molecular basis for disease, through increasing sophistication of biological research, will strongly influence the design of new synthetic drugs, providing for efficient action against disease with less danger of harmful side-effects.

Likewise, new knowledge about mechanisms by which hormones regulate life processes, and the influences of aging and disease on such activity, make it possible to design drugs which can exercise effective control of metabolism during disease and aging. If successful, the process of aging may be retarded and senility reduced, resulting in a longer span of useful life.

IN the past few years, several pharmaceutical products have been made available which effectively lower the blood pressure, and along with diuretics, are helpful in sustaining the health and prolonging the lives of patients suffering from hypertension. More effective heart disease drugs to reduce fatty deposits that clog blood vessels are being prepared for us. And permanently installed artificial pacemakers using synthetic piezoelectric crystals to generate sufficient electric current from the movement of the diaphragm will offset damage to the cardiac nerve centre, prolonging life with greater ease for those inflicted with heart trouble.

If, as recent findings of Dr. Howard M. Temin and Satoshi Mizutani seem to confirm, some forms of cancer are caused by viruses, preventive and therapeutic vaccines can be expected to replace surgery as the principal form of treatment for this dreaded threat to human life. Cancer appears to be not one, but a variety of diseases, so that several approaches will probably be required to control it. Well-defined programmes of nucleic acid research, with focus on new prospects of medicinal chemistry, offer hope of new anti-tumour drugs and agents active against leukemia.

Powerful new weapons against viruses of a wide variety will be in use before 1985. Here, some sensational developments are predictable. Anti-viral drugs and products of nucleic acid research to cure influenza and the common cold can be anticipated. Some new anti-viral drugs will not be specific to one particular virus, but will affect a spectrum of viruses, probably including useful bacteriophages that attack bacteria.

Careful structural molecular analysis has also led to experimentation with cage-shaped vaccine molecules that interfere with viral attachment to or penetration of human cells on the perfectly sound theory that prevention of cell penetration will render the virus harmless. Other drugs will interfere with the assembly of viral components, or simply mislead viruses by the induction of faulty coding. Vaccines against mumps and German measles have been developed and another recent discovery — 55-fluorodeoxyuridine—is effective in treating herpes of the eye.

These are small, but meaningful, triumphs. With the understanding of the nature of viruses and their reproduction growing rapidly, however, the current rather unimpressive cupboard of antiviral drugs will be expanded steadily in the next two decades to lighten the human burden of disease.

A new breakthrough in the long struggle against schistosomiasis has produced a promising new drug, niridazole, which stops egg laying by schistosoma worms, destroys the eggs inside the human body, and kills the parent worms, curing the patient and helping to obstruct perpetuation of the parasite—all in one concerted action.

Described by Prof. A. W. Woodruff of the London School of Hygiene and Tropical Medicine as "the most exciting therapeutic innovation in this, and perhaps any, field since the introduction of antibiotics", niridazole is expected to bring relief to between 200 and 300 million people in Asia, Africa and Latin America who are infected by the disease.

Serendipitiously, niridazole also has proved to be an effective weapon against guinea worm, amoeba and certain types of leishmania— three debilitating parasites which continue to be major health problems in tropical areas. By 1985, nucleic acid research is also expected to produce new active agents against parasitic and other tropical diseases.

Recent research has also focused attention on various aspects of immunity, other than those involved in the use of prophylactic vaccines. New drugs designed to cure or relieve arthritis and multiple sclerosis, which appear to be manifestations of auto-immune phenomena, are on the horizon.

The early generation of immuno-suppressive drugs has already made possible such success as has been obtained in organ transplantation. The search for better agents, again through nucleic acid chemistry, will continue, particularly for pharmaceuticals which, when use has been discontinued, permit full recovery of the immune mechanisms.

Attempts are also underway to isolate new hormones, improve oral contraceptives as well as produce more potent non-addictive analgesic drugs, sedatives that do not cause drug tolerance, better anti-inflammatory and anti-ulcer drugs, and compounds that prevent or control osteoporosis (a disease of the bones).

In addition to what may be thought of as classic medicine, there is an ever-increasing number of drugs being developed to influence the mind and nervous system. Numerous drugs to control memory and learning are already available. Ribonucleic acid, a genetic messenger, is said to actually stimulate the brain's memory cells. Among the beneficial therapeutic uses of the drug is the treatment of senility; but it has much broader implications. Certain hydrazine derivatives have made chemotherapy of mental depression possible, and led to the introduction of anti-depressants for use in treating mental disorders.

Still another psycho-pharmaceutical substance selectively relieves anxiety and tension along with their organic manifestations, without impairing physical and mental alertness. Drugs for the treatment of tension and compulsive neuroses, euhypnics which induce sleep by shielding the sleep mechanism from disturbing stimuli of emotional, sensory or autonomic origin have also been, developed.

BUT the frightening aspect of all this is the use to which chemical brain-control agents may be put. Some scientists believe it may become possible to control the individual and entire societies, and to do all this unobtrusively without the active co-operation of the victims.

Chemicals could be placed in water supplies, food or the air we breathe, to work on a mass basis. Or a prescribed psychological environment in the very early periods of an individual's life might be used to produce inferior brains and people on the one hand, and superior brains and people on the other — thus creating the master group and the subservient group envisaged in Huxley's "*Brave New World.*"

All this is, of course, speculative—but possible within limits of present scientific knowledge. Self-abuse of psycho-pharmaceutical drugs is already with us, indicating a certain misplaced emphasis in the analysis of social problems these new discoveries pose. The challenge is not the social responsibility of the scientist who contrives a new brain-control compound; whether the new discovery is used to good or bad ends depends on individuals and the social controls they are prepared to sustain.

THE CRANES ARE FLYING in this modern age and carrying their nests with them. 500 feet above the outskirts of Stockholm, a giant helicopter carries an artificial fibre summer residence to a new site. Designed by Finnish architect Matti Suuronen, it is ready for immediate occupation by four people. Furniture, household equipment and electric central heating are all incorporated in the original design and even the windows are made of synthetic material. Now being mass-produced in the United States, these discus-shaped dwellings are in great demand for motels and as temporary housing for workmen on building sites.

Photo © Pressens Bild AB, Stockholm

4

The 10,000 metamorphoses of plastics and synthetic fibres

IF chemistry has revolutionized agriculture and the practice of medicine in the last generation, its impact upon the quality of life has been hardly less far-reaching through the development of plastics. Plastics, the only new twentieth century technology to emerge as a basic industry, has enabled man to fashion materials to meet his specific needs rather than adapt his needs to the availability of nature's substances as they occur.

Other basic materials—glass, iron, steel and the non-ferrous metals, ceramics, concrete, timber and natural fibres—all existed before the beginning of the Greek era. Paper was invented by the Chinese much later, about the time of Christ. Until the development of plastics—looked upon until only a very few years ago as "substitutes" rather than as a major

CONTINUED NEXT PAGE

XUM

new technology—modern man had added only rubber and aluminium to his available materials.

Yet plastics, structured from matter rather than specific substances and capable of being fashioned according to the intended end-use, are only the beginning of a new materials technology. New composite materials with specific microstructures of atoms and molecules designed with the desired physical, chemical and electrical characteristics will be the products of physical chemistry and quantum mechanics with which we will fashion the clothing we wear, the homes we live in, the buildings in which we work, the cities of the future.

Fully synthetic fibres, rapidly replacing natural fibres, have produced a veritable comfort revolution in the past ten years. Durable press fabrics have made the most spectacular changes in fibre use patterns, in textile processing and economics and in the lives of consumers, of any single innovation that has ever appeared on the textile scene.

As a result, while the consumption of cotton remained stable throughout the 1960s, polyester production for apparel and home-furnishing fabrics increased by a factor of 20 and is expected to triple in the present decade. Improvements consumers can expect in the fabrics they use during this period include better stain removal, higher soil resistance, greater resistance to burning, and lower static buildup.

Stretch, or spandex, fibres that have brought such radical changes to women's fashions, will also find much wider future use in all types of men's and women's garments. The improved comfort, fit and draping qualities obtained are possible when only a small amount of spandex is incorporated into a fabric.

Only slightly less visible than the influence of new fibres on fashions is the renaissance of the wig and hairpieces for women and, to a daily increasing extent, for men, provoked by the advent of modacrylic fibres.

While these innovations may be more social than utilitarian, their main object is to enable people to enjoy, or at least not be ashamed of, their appearance—a most welcomed contribution to the quality of life.

But new synthetic fibres have also brought new comfort , styling and ease of maintenance to the home. New fabrics for floor coverings, draperies and upholstery have lustre and beauty, long life and ease of cleaning and maintenance. Use of carpeting in the home, hotels and business places has increased almost four-fold in the past ten years, and lower prices, greater durability and low cost of maintenance is expected to further expand its uses—even for outdoors.

Similarly, wall coverings in fabrics, which have functional advantages of insulation and sound proofing as well as exciting new decorating and styling possibilities, will make their modest contribution to the improvement of man's environment at home and at work.

Still more exotic fibres are available today for a wide variety of industrial and construction uses, Highly flexible fibrous materials produced in metallic, ceramic and carbon compositions are used as separators and matrices for high temperature fuel cells and other multiple layer insulation, reflectors and insulation for inductively heated and resistance heated furnaces, reinforcements for materials used in nozzles and heat shields, high temperature filter media for bases and metals, porous diffusers for infrared burners, and catalyst supports.

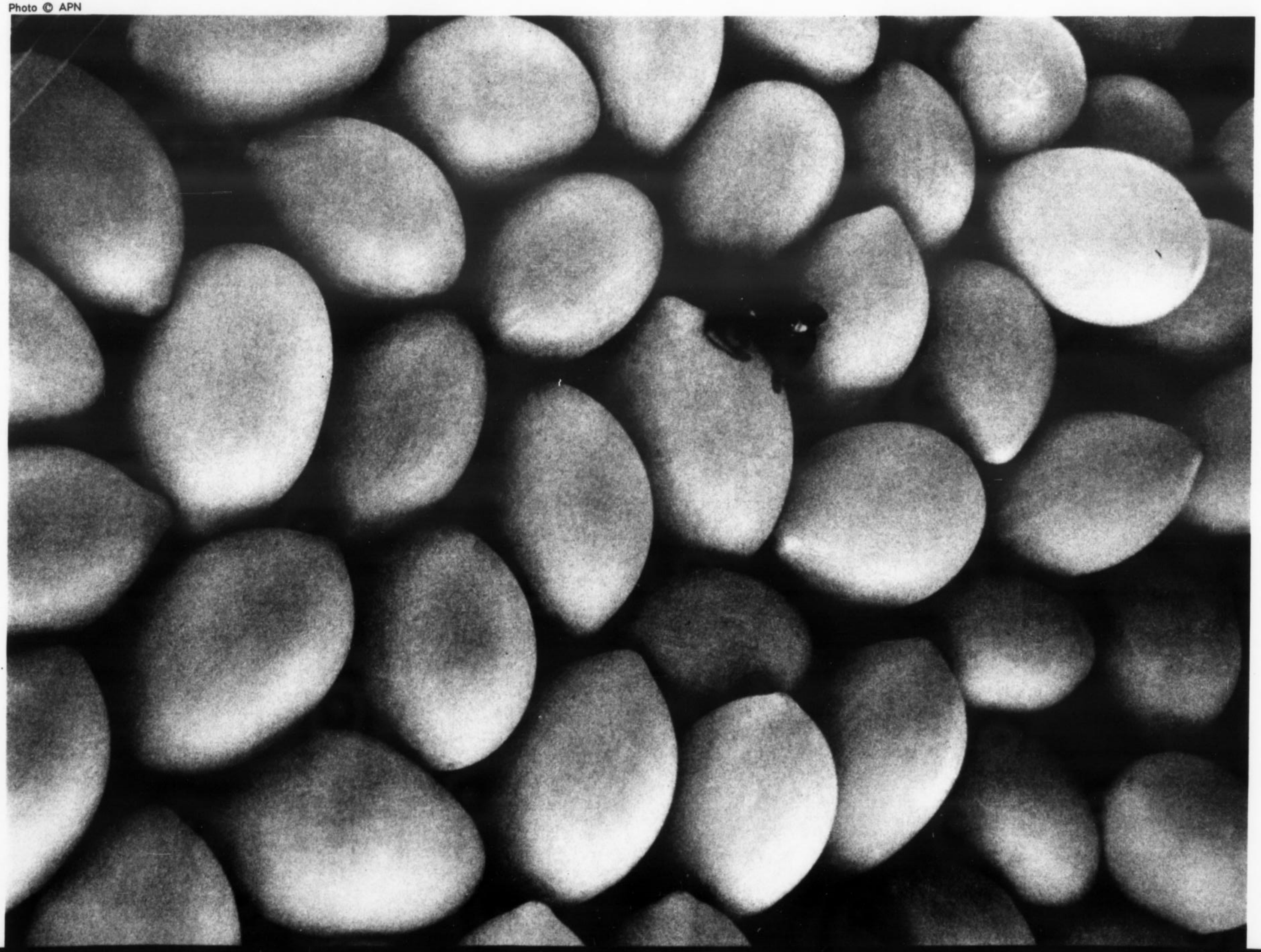
CONTINUED PAGE 20

STRATOSPHERIC 'LEMONS' AND CLOTHES FOR AN INFERNO

Brobdingnagian "eggs" or "lemons" (right) are really giant balloons for stratospheric research made out of synthetic rubber, being inspected at a factory in Kazan on the Volga river in the U.S.S.R. The new world of synthetic materials created by modern chemistry includes a broad selection of heat-resistant polymers. These range from materials that protect metal from temperatures as high as 4,000 degrees F. for short periods, to nylon fibres for protection against heat and flame. Unlike asbestos, this new cloth can be made into garments that protect firemen (below) and those doing jobs with serious fire hazards, while allowing them to work as easily as if they were wearing ordinary clothes.

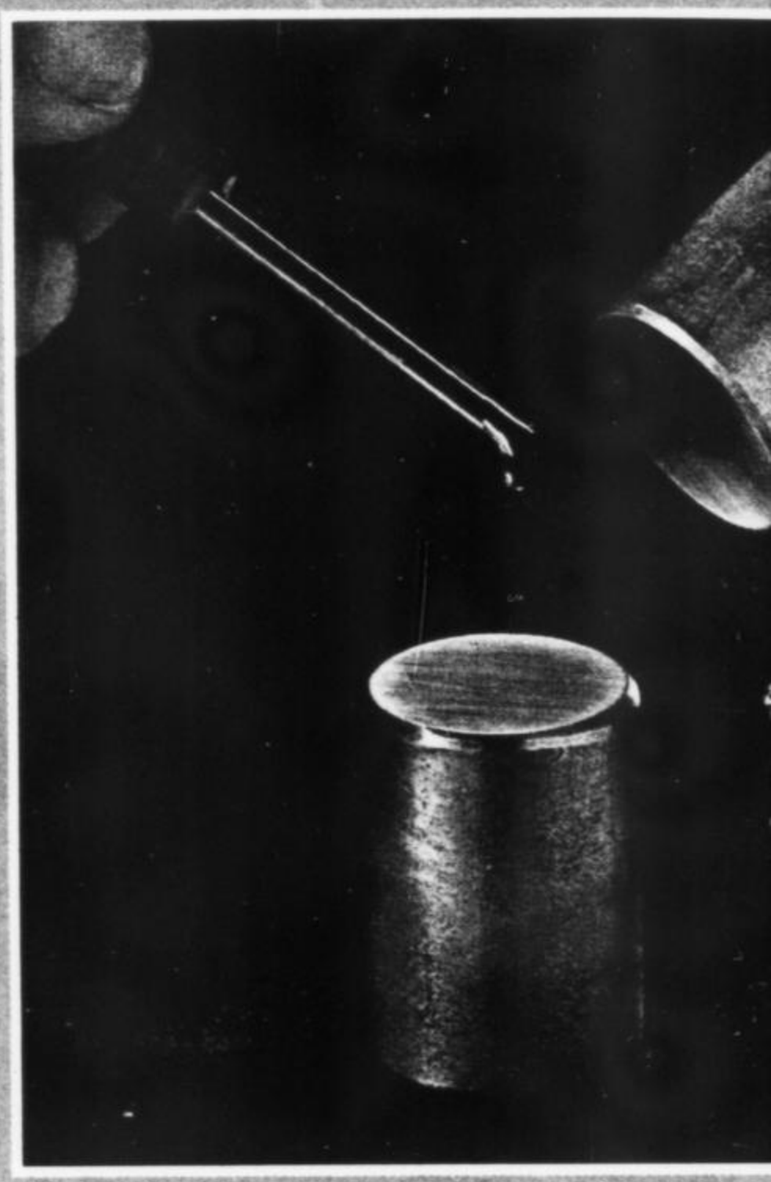
Photo © DuPont, New York

Photo © APN



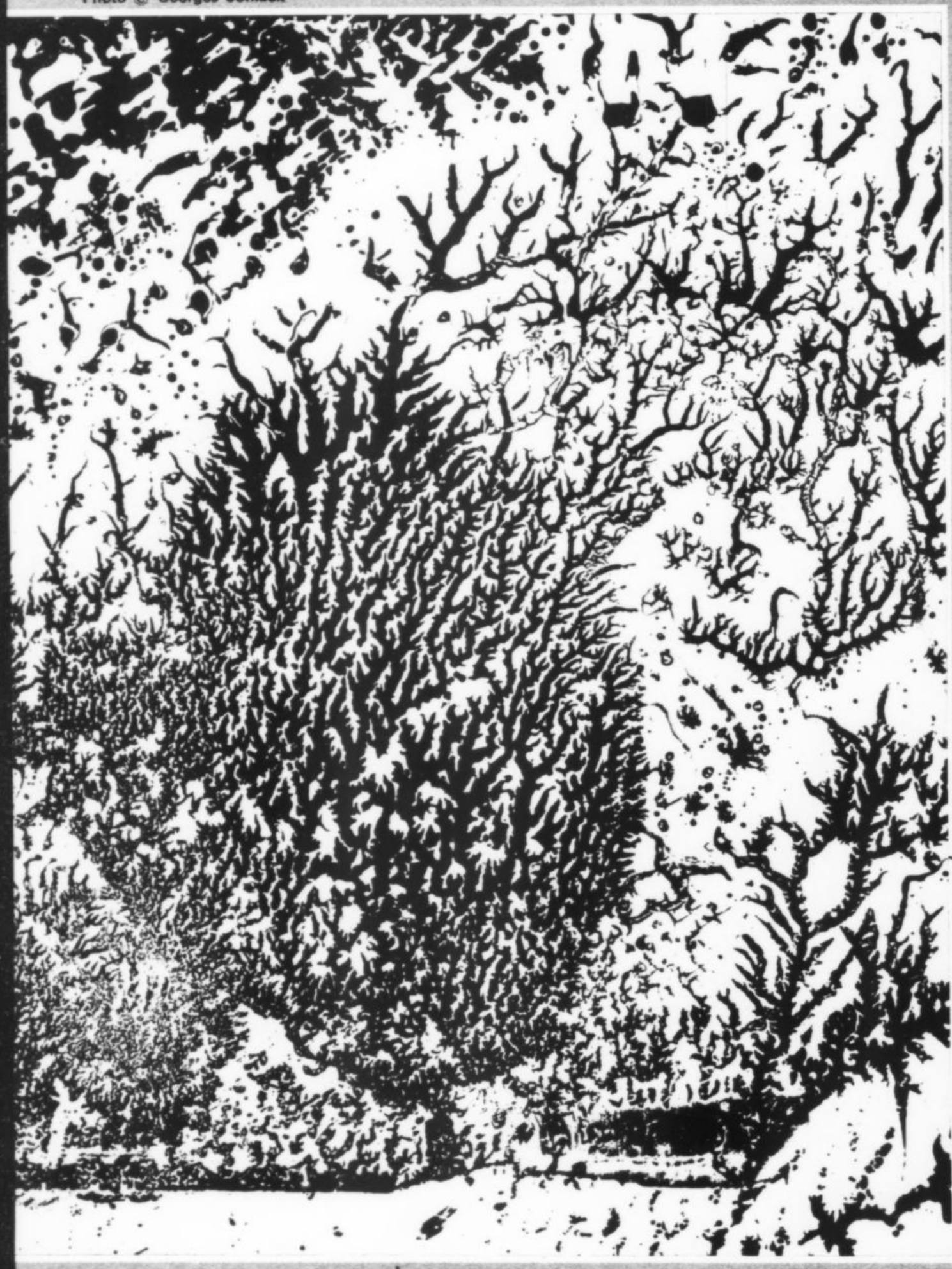
ONE DROP OF GLUE DOES THE TRICK

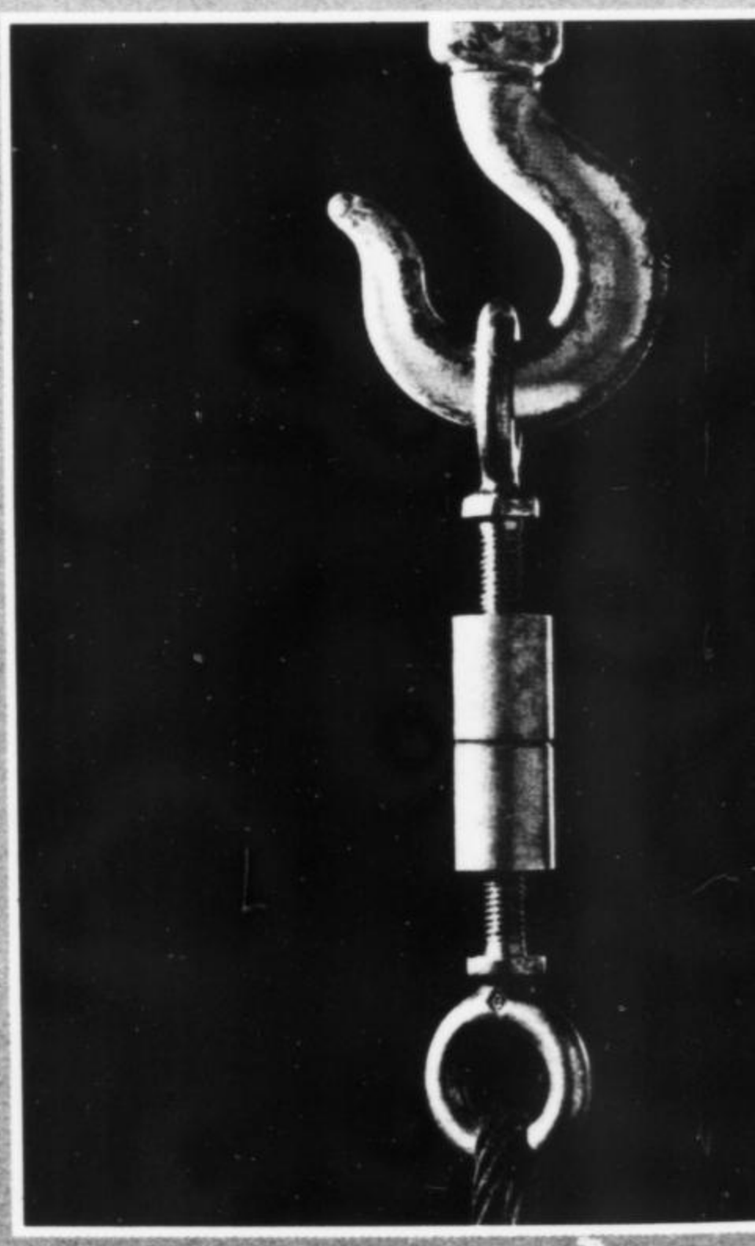
When does a single drop of "glue" have the sticking power to support a half-ton weight? The answer: when it's a new-type plastic adhesive. The ability of high-strength adhesives to weld two materials into a virtually permanent union is demonstrated in photos on this page. With the development of plastic adhesives that are stronger, lighter and easier to use than conventional fasteners, screws and bolts, rivet and nails may one day become obsolete. Houses, cars and planes may eventually be completely glued together as furniture is today. Below, delicate traceries produced by glue used to join two sheets of glass. Pattern was revealed when the sheets were wrenched apart during research.

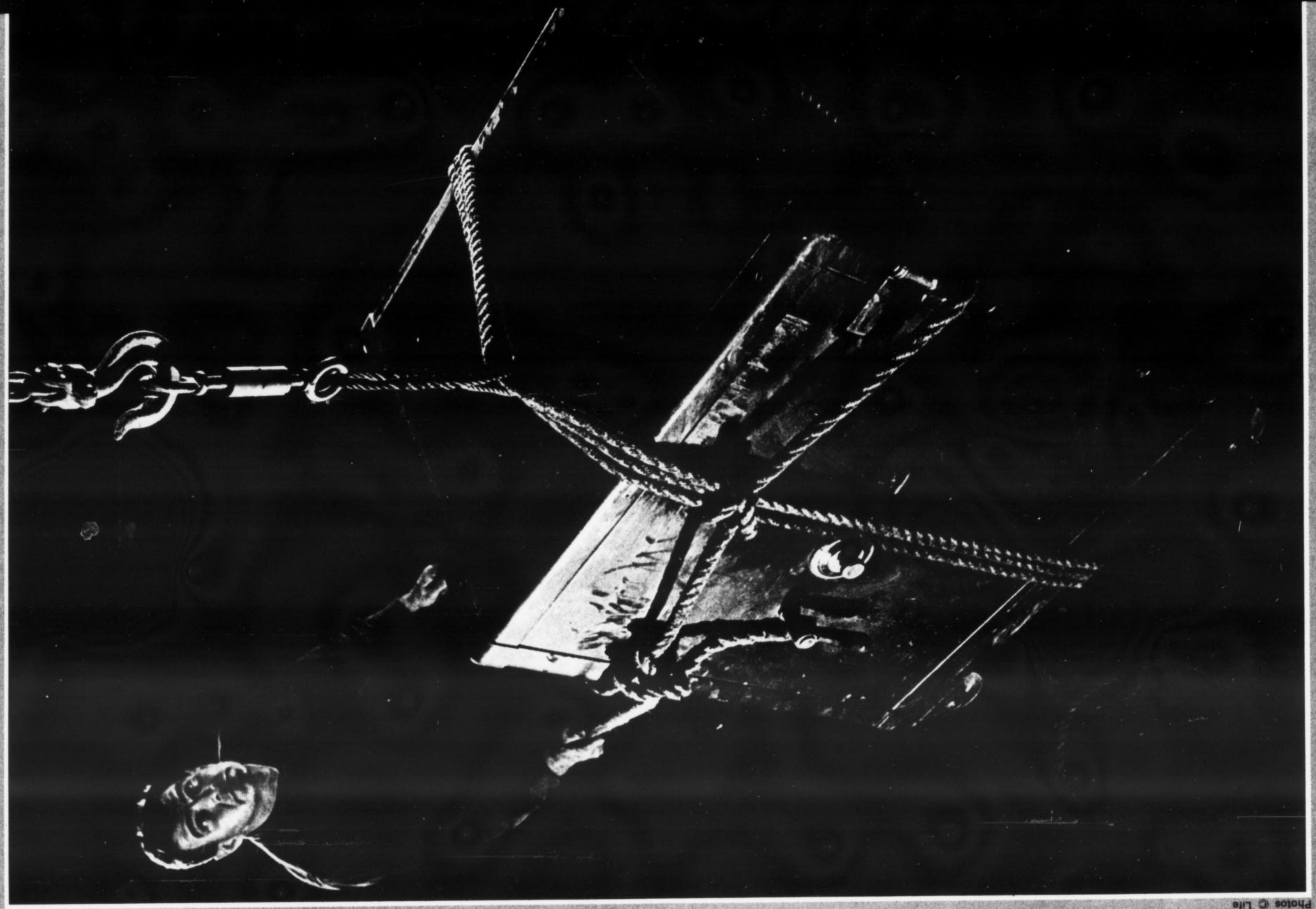


Above and below, a single drop of glue is used to join two steel cylinders together to become part of a heavy-duty hoist. The liquid solidifies on contact, the tiny amount of moisture and oxygen present on almost any surface being sufficient to trigger off the process. Within minutes the chemical weld created by the drop is strong enough to support the weight of a 1,200-pound safe (right).

Photo © Georges Joniaux







Photos © Life

Photo Serge de Sazo © Rapho, Paris

MODERN CHEMISTRY *(Continued from page 16)*

Carbon and graphite fibres, produced by the decomposition of rayon or acrylonitrile polymers under carefully-controlled conditions, are the highest strength-to-weight and modulus-to-weight engineering materials man has yet been able to devise. Because of high production costs, these yarns are used only in special applications such as nose cones of aircraft, spacecraft and sensitive radar housings in remote arctic locations.

What synthetic fibres have become for clothing and home furnishing, solid plastics developed from the same resins are rapidly becoming for home construction, furniture, household appliances, motor cars and industry.

Environmental conditions which can maintain ideal climate, pure air, and freedom from noise, making available to the average home dweller the seclusion and comfort once limited to a privileged few, are now within reach, thanks to plastics technology.

Special lighting, enhanced by the use of electroluminescent plastic panels, together with radiant heating built into neoprene ceilings, will soon bring these comforts to millions of families. Wall and ceiling panels made of plastic foam sandwiched between thin metals, ceramic, pressed wood, or plastic sheets, will have light-weight, high-insulation properties and the strength of metals—a boon for new labour-saving, prefabricated construction techniques. Surface coatings of foil, film, sheet, or spray will be tough, durable and colourful.

A new "systems concept" of construction, providing architects and builders with engineered plastics specially designed to perform specific functions, in combination with other products and materials used in a finished structure, has opened up broad new horizons for housing and building construction.

The results are huge savings in time and money, along with improved insulation, structural integrity and creature comforts. Use of black anodized aluminium backed with urethane foam insulant enabled Chicago architects to design the Windy City's futuristic 100-storey John Hancock Center for construction at costs of a conventional 45-storey building: $95 million.

Synthetic products used in this and other high-rise buildings include corrosion-resistant bearings, adhesives said to be 30 times stronger than ordinary cement-lime mortar and 10-30 per cent cheaper, gypsum wallboard, butyl rubber glazing tape and neoprene rubber strips around windows, vinyl-asbestos floor tiles, plastic laminate panels in elevators and offices, synthetic fibre carpets, protective and decorative surface coatings and bronze-tinted glass windows.

Still other shapes of the future, made possible by products of modern chemistry, were heralded by the dazzling and bizarre collage of structures assembled in the Senri Hills outside Osaka for Japan's Expo 70. Although designed primarily to

Photo © Rapho, Paris

"Schematism", says the dictionary, "is the arranging of parts or particles in a pattern according to a scheme." The "Ski-mat-ists" in our photos are gliding in hot summer sunlight on artificial ski slopes made of synthetic sheeting to which a carefully worked out pattern, below, has given the consistency and qualities of snow. All year round skiing within the reach of all is now a reality for youth in Yomiuriland, Japan, left, and denizens of Dieppe, France, far left.

WHERE ARE THE SNOWS OF YESTERYEAR ?

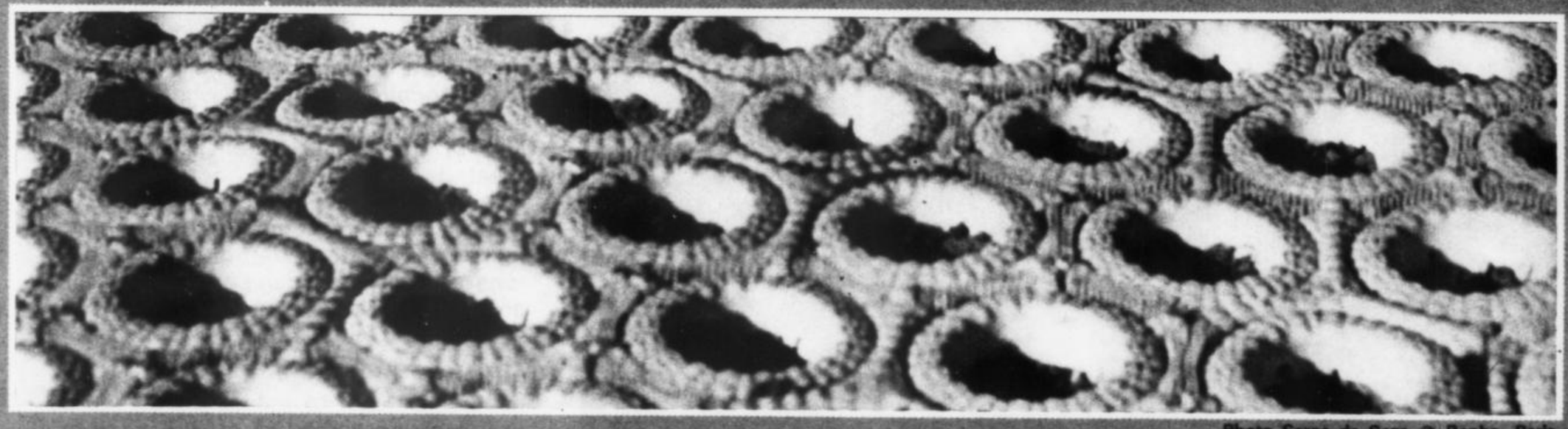


Photo Serge de Sazo © Rapho, Paris

amaze and delight the eye, the buildings at Expo also incorporated many sound structural innovations that could influence building trends for years to come.

Certainly, the extensive use of elastomeric building materials for air-supported structures indicates the progress that synthetic rubber may expect to make in the construction field during the next decade or two. More than twenty buildings utilized newly developed neoprene joining techniques which reduce critical construction times and assure resilient and weatherproof structures.

These materials are already finding wide application in less exotic structures the world over. A new industrialized building system, remarkable for its simplicity, flexibility and speed has been developed in France by a group of architects and industrialists using a patented innovation—a moulded fixation point for aluminium mullions—used in the facades of their multi-storied apartment houses.

A vast roof of unique design, covering a new gymnasium at Princeton University in the U.S.A. has a weatherpoof coating of neoprene and Hypalon synthetic rubbers, giving it added weather resistance, flexibility and durability. A French fruit-grower near Avignon has been able to store fruit for three months longer than usual and at a much lower cost than in conventional structures, by using inflated refrigerated warehouses, made from synthetic rubber coated fabric that very much resembles structures of the Osaka Fair.

New materials for new devices will also play many hidden rôles in home and office buildings. Packaged power units, whose future availability depends in large measure on present-day materials research by the chemicals industry, will reduce noise and air pollution. Direct energy converters and efficient storage batteries, taking their charges during off-peak-load periods, should improve economy and reduce electric power costs.

Packaged power is already in wide use for flashlights, hearing aids, portable radios, electric shavers and the like. By 1985, small batteries in the pockets of light weight apparel made of new synthetic fabrics will provide well-regulated body-environmental temperatures without the need for heavy overcoats. Larger batteries will furnish motive power for automobiles and an increasing percentage of other land vehicular transportation.

With the possibilities of greater leisure both from work and household chores, plastics and other new materials will play an increasing role in facsimile information services, video and sound tape recordings, art works and published materials.

A whole new generation of television receivers is likely to be the first futuristic electronic device, made possible by the development of ferro-electric crystals and electroluminescent layers made of copper-activated zinc sulfoselenide phosphor particles encapsulated in a resin. Similarly,

CONTINUED NEXT PAGE

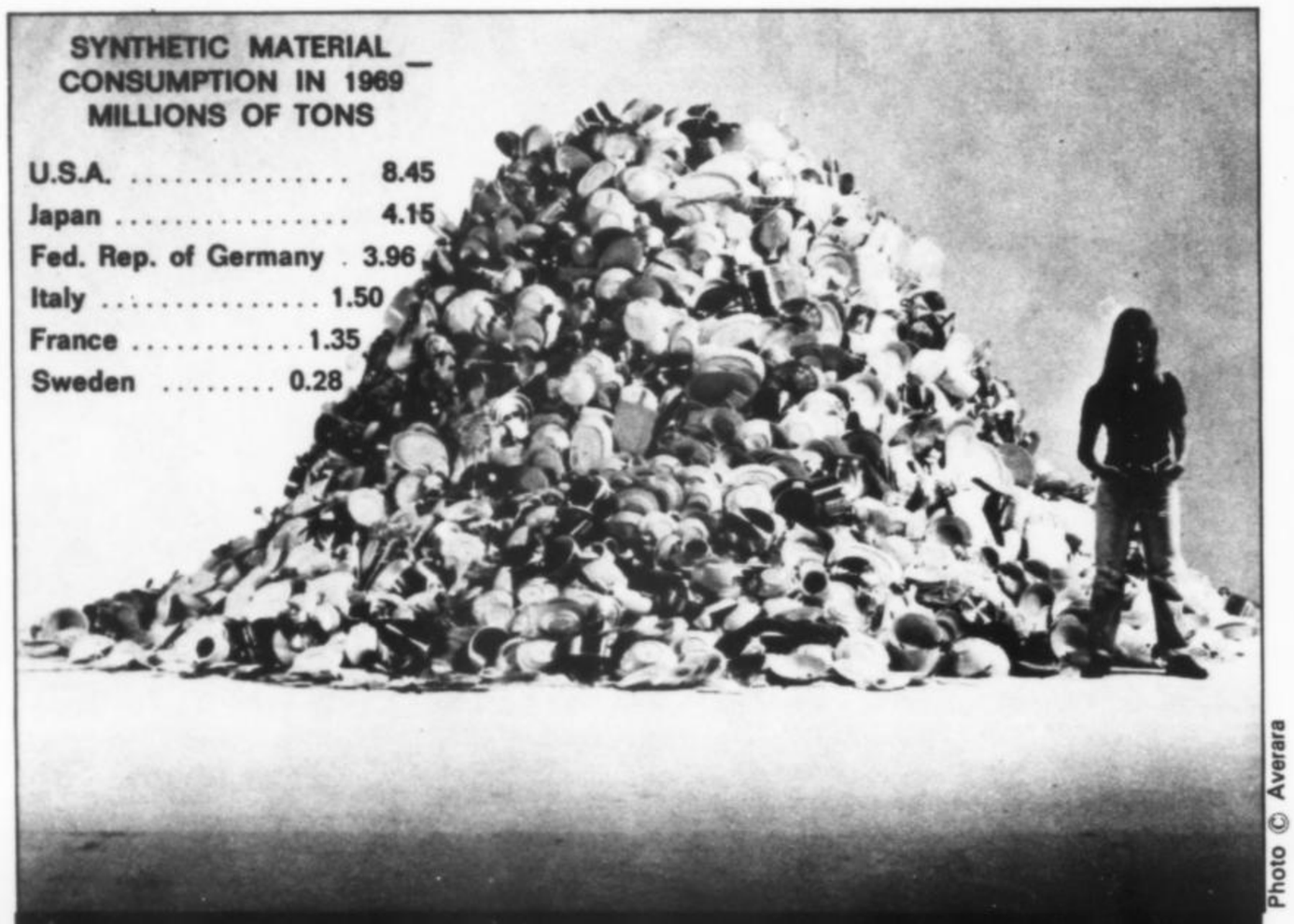

SYNTHETIC MATERIAL CONSUMPTION IN 1969 MILLIONS OF TONS
U.S.A. 8.45
Japan 4.15
Fed. Rep. of Germany . 3.96
Italy 1.50
France 1.35
Sweden 0.28

Photo © Averara

WHERE'S THE DISHWASHER?

If it's your turn to wash the dishes the odds are that they will be made of some kind of synthetic material. The world's largest producer of plastic materials, the United States (8,314,000 tons in 1969), has a lower per capita consumption (35 kilos in 1969) than the Federal Republic of Germany (44 kilos) and Sweden (38 kilos). The use of plastics is growing in Japan (32 kilos per capita in 1969), but is still comparatively low in France (23 kilos) and Italy (20 kilos).

The ecological imperative

standard telephones operating on sound waves may soon be rendered obsolete by a system in which laser-generated light—modulated by ferro-electric crystals such as lithium tantalate—will carry many times the volume of information that can be transmitted by present telephone circuits.

It is not known exactly when man identified pollution as a problem. Not only was it beneath the dignity of ancient writers to discuss the matter; it wasn't an issue. Pollution was a part of life.

History does, however, record that the early Romans complained that a black soot in the air smudged their togas. And in merry old England there was once a law prohibiting the burning of a certain low grade of coal. Violation was punishable by death, and King Edward I (1272-1307 A.D.) is known to have enforced the penalty.

But pollution in those times was of a different order than the pollution we have today. Life was simple, and society was far from affluent. Very little in the way of effluent wastes was created and almost nothing was thrown out. There were no nations with 85 million automobiles to account for some 40 per cent of 200 million tons of emissions dumped into the air annually as residue of human activity —as in the United States today.

Thanks to modern technology, we have been able to achieve a standard of living undreamed of even a century ago. But in the process we have also created many pollution problems.

The problems are new, different, bigger and they are demanding and getting a growing amount of our attention, time and money.

Just as chemistry has provided modern man with tools to conquer hunger and disease, to provide improved clothing and shelter, it is the principle means at our disposal for the conservation of our environment.

After seven years of research, the chemical industry has perfected an exhaust manifold reactor, a noncatalytic unit that thermally reduces the gaseous emissions of conventional auto engines; it will control the two principle problem pollutants generated by auto engines: hydrocarbons and carbon monoxide. Fibres and plastics are used in a number of other filtering and reclamation processes, while chemicals and intermediates are used in purifying and catalytic systems.

While the apparatus that will filter, trap or dissolve all pollution materials discharged by oil refineries, chemical plants, steel mills, paper plants and building incinerators has not been

built yet, progress has been made with the recent development of cellular ceramic materials resembling honeycombs that are effective in fume abatement. When covered with a precious metal or metal oxide, these honeycomb structures cause oxidation as the fumes pass through.

Nylon and tetrafluorocarbon fibres are also being effectively used in many dust collection systems, particularly where heat resistance is required. Filter bags in a variety of fabrics and types are doing service in more than a dozen industries, including iron and steel, chemical, cement, gypsum, quarrying, carbon black, zinc, soap, smelting, asphalt and the reclamation of metals.

Somewhat more success has been obtained with water purification systems. Direct oxygenation systems have substantially improved the effectiveness and lowered the cost of the secondary activated sludge wastewater treatment process used by most municipal and large industrial systems.

Nylon and polyester fibre permeators that can make brackish water fit to drink may also be used to remove certain pollutants from sugar, paper, pharmaceutical, chemical and dairy industries.

In other preventive applications, synthetic rubber lining is being used for storage of brine, hydrocarbon oils, fuels and chemicals to prevent seepage which might contaminate streams, the soil and subsurface waters.

In what amounts to the most concerted scientific effort in history, one far more extensive than that of the space programmes of the 1960s, hundreds of governmental and industrial research laboratories are engaged in the search for new products and new technologies to meet the mounting demand for pollution control and maintenance of a continuing balance in the global ecosystem.

Just as astronomy was the basic science around which a vast constellation of physical and social sciences were combined with the humanities in a systems approach to the conquest of space, chemistry must be the focus of a similar global systems approach to environmental control and improvement.

As an executive in a leading international chemical company pointed out recently in Zurich, "the restoration of the environment is essentially a chemical problem which has to be solved in the chemical laboratory and by the massive application of chemical products to neutralize the insalubrious waste of our industrial society."

Within the next ten years the first results of this intensive research effort will begin to have a noticeable impact. By the year 2000, chances are that the combined efforts of science, industry, academia and governments will have gone far toward meeting the ecological imperative. ■

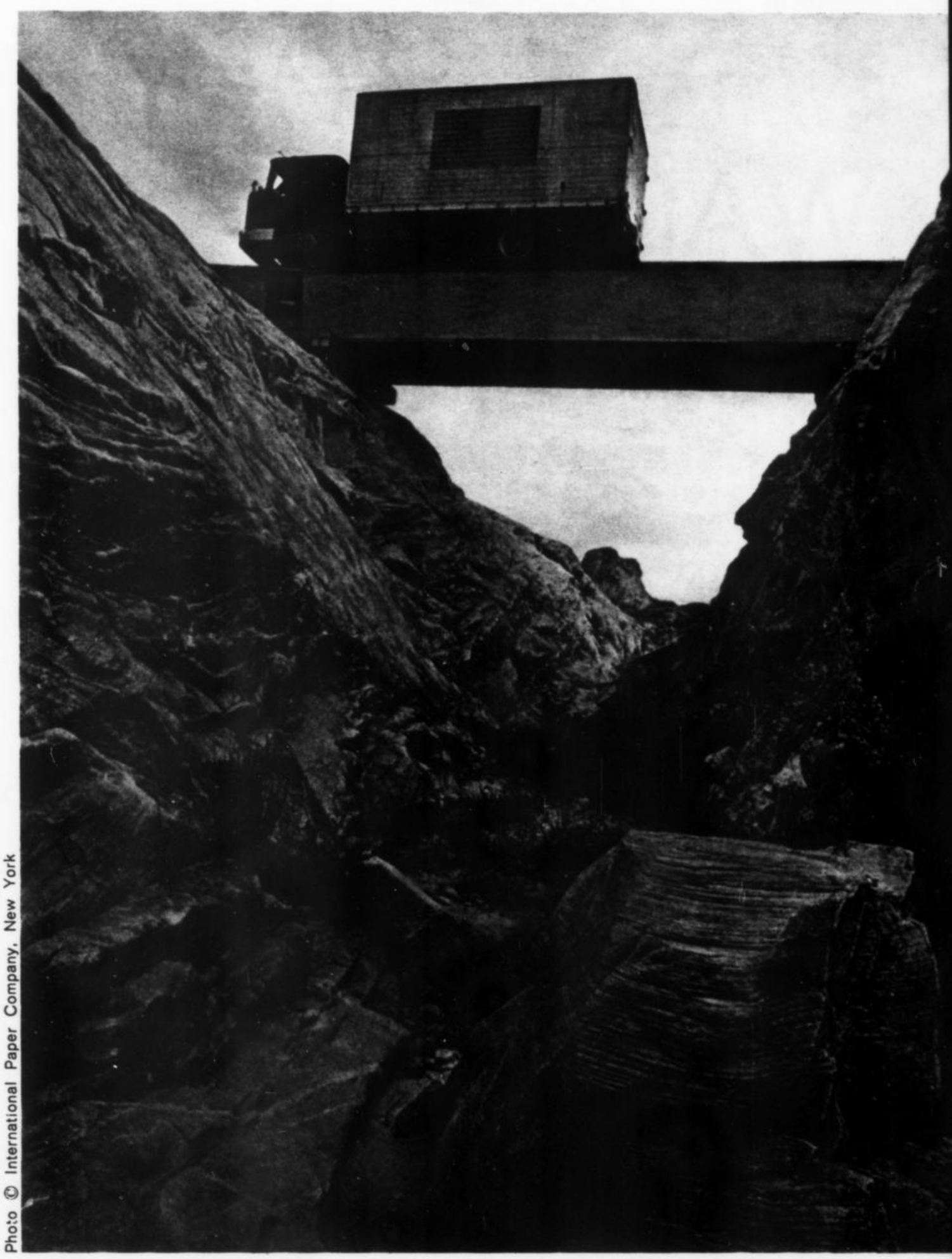


Photo © International Paper Company, New York

BRIDGE MADE OF PAPER. "On paper it's possible", said the structural engineers when asked to design a new type of bridge; and this is exactly how this 12,000 lb truck is crossing the gorge—on a 32 ft bridge made of specially processed paper. The bridge was constructed by American paper manufacturers merely to demonstrate the strength and versatility of paper, not as a commercial enterprise. Engineers calculated that the bridge could carry a weight of up to 30 tons, yet it was light enough to be put in place by a helicopter. Newly discovered glues helped to make this feat possible.

XUM

THAT CHART ON THE LABORATORY WALL

by Ghenrikh Teterin and Claire Terlon

SOME of the basic substances in nature, which we call elements, have been known since early antiquity. But it is only during the past century that man has learned that there are about a hundred elements, and begun to understand how these are similar or different.

The work of Copernicus and Galileo had earlier brought order out of chaos in astronomy, Newton did much the same for mechanics, then Darwin and Pavlov for biology, while much later Bohr and Einstein were to make significant contributions to the physics of the atom. In chemistry, one of the great moments came in 1869 when the Russian researcher Dmitri Ivanovich Mendeleyev formulated the periodic law of the chemical elements.

The formulation of the periodic law marked the passing of the study of chemistry from almost medieval trial-and-error methods to a modern science capable of predicting elements not yet seen, heard, touched or smelled by man. The coherent arrangement of the elements by Mendeleyev crowned the efforts of men of science in many countries to discover a meaningful system in the properties of these basic substances.

Mendeleyev's idea was to be virtually a quantum jump from the simple table laid out in the eighteenth century by the French chemist Antoine Lavoisier who had included, besides physical elements, what he called "imponderable fluids," such as light and the energy derived from heat.

Although a far cry from Mendeleyev's rigorously logical approach, Lavoisier's effort succeeded in conditioning other scientists to reject the theory of phlogiston. This was the ancient chemical concept, dating from early Greek civilization, that fire in its various forms was a physical or material component of nature.

Lavoisier's analysis was improved upon in 1803 by the British chemist John Dalton and his atomic theory which attributed a distinctive atomic "weight" to each of the 23 elements admitted by Lavoisier. Characteristics

CONTINUED PAGE 26

GHENRIKH TETERIN *of the U.S.S.R., is head of the Scientific Laboratory at Odessa State University, in the Ukraine, where he has worked in the fields of physical and electrochemistry. He has also carried out research at Rensselaer Polytechnic Institute, in the U.S.A., under the U.S.S.R.-U.S.A. scientific exchange programme. Dr. Teterin is at present working with Unesco's Division of Science Teaching. He has written widely on physical chemistry and is the author of many popular science articles.*

CLAIRE TERLON, *of France, is a specialist in physics as well as psychology. As a member of the Institut Pédagogique National in Paris, she is responsible for the preparation of special television refresher courses for chemistry and physics teachers in French lycées. She is a regular contributor to the French science magazine "La Recherche-Atomes".*

This Soviet stamp, issued in 1934 to mark the centenary of Mendeleyev's birth, shows him seated in front of his now familiar Periodic Table of Elements.

In 1969, several countries commemorated the centenary of the Periodic Table of Elements by issuing a series of stamps in honour of its creator Dmitri Mendeleyev. The discovery by this Russian chemist that a natural order existed among the elements was one of the greatest and most patiently won achievements in the history of scientific research. The U.S.S.R. stamp, below, is printed on a fascimile of an early version of the Periodic Table in Mendeleyev's own handwriting, dated 17.2.1869. Above the table he has written, "Draft of a table of elements according to their atomic weights and chemical properties by D. Mendeleyev." Left, another Soviet stamp shows the bearded figure of the scientist at his desk working out preliminary atomic weights.

Dmitri Mendeleyev
the man who brought law and order to chemistry

DMITRI Ivanovich Mendeleyev was born in the Siberian provincial town of Tobolsk in February 1834. The youngest of 17 children, "Mityanka" as he was known to his friends, showed an early aptitude for physics, mathematics and history—but disliked Latin.

When he was 13 his father died, yet despite the hardship this brought to the family, young Dmitri was able to complete his studies in mathematics and physics at the Central Pedagogical Institute in St. Peterburg (now Leningrad).

Even before being awarded the Institute's Gold Medal, Mendeleyev had become fascinated by the possible relationships between the chemical properties of the elements and their physical structure.

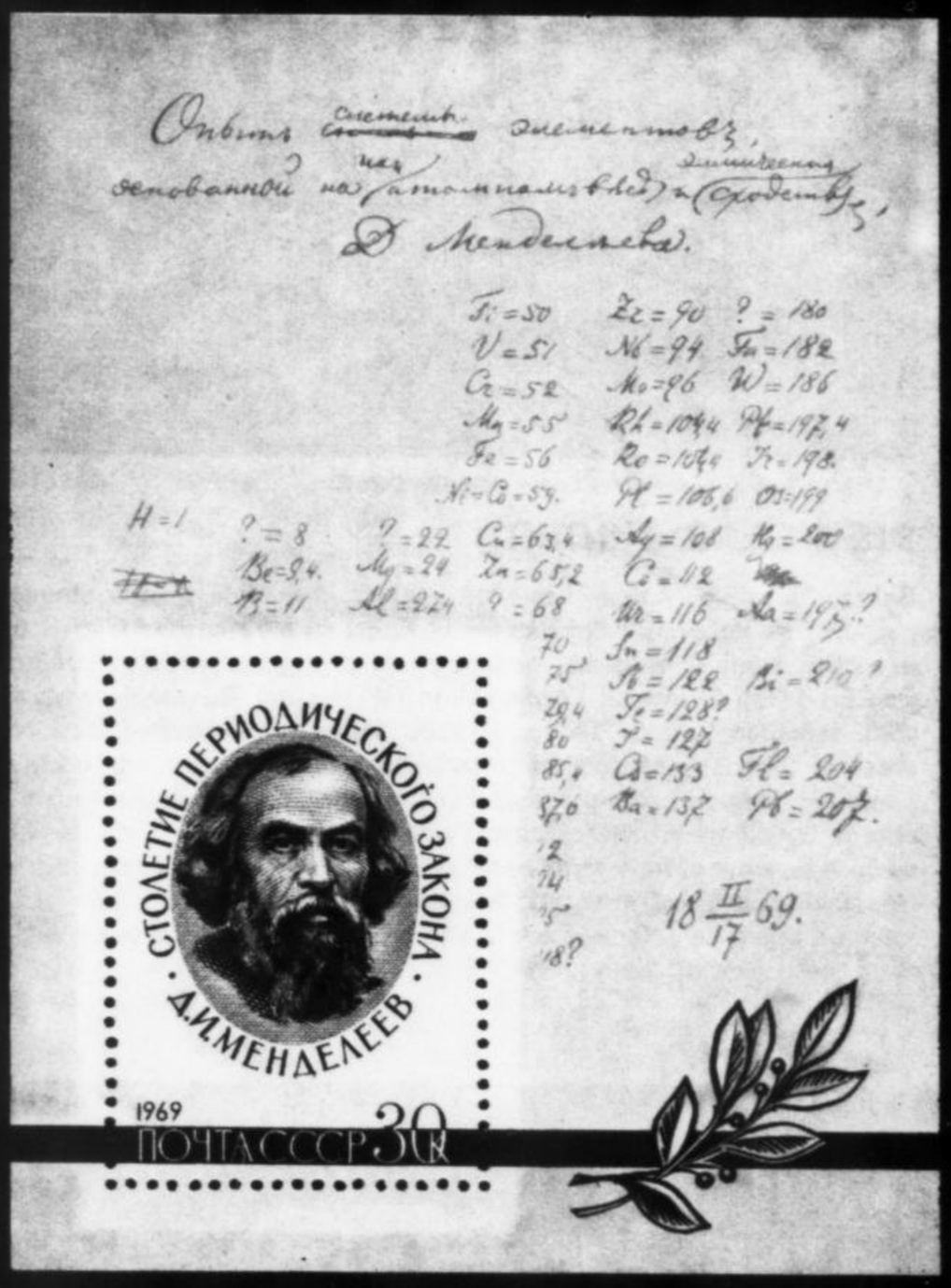
After several years in Odessa and St. Petersburg, Mendeleyev worked from 1859 to 1861 in Paris with the French chemist and physicist Henri Victor Regnault, and also with the German chemist Robert Bunsen, in Heidelberg.

It was during his stay in Germany—in a laboratory he had arranged in his own home—that the young chemist established the concept of critical temperature (above which a gas cannot be turned into liquid by pressure alone). And in nearby Karlsruhe he met the Italian chemist Stanislao Cannizzaro.

Mendeleyev called Cannizzaro "my real predecessor... I observed immediately that the changes in the atomic weights which he proposed lent a new harmony to the groups suggested by Dumas," (professor of chemistry at the Sorbonne). "The idea of a possible periodicity in the properties of elements in relation to their ascending atomic weight occurred to me as of that moment."

By the age of thirty-three, Mendeleyev had been named professor of general chemistry at the University of St. Petersburg, at that time Russia's most important chair in chemistry.

It was during this period that Mendeleyev began compiling one of his major works, "The Principles of Chemistry" (published in 1868). In writing this book he squarely faced the problem of how to present the elements and their relationships. Again and again he compared their properties in the hope of finding a key to the solution.



Describing his discovery, Mendeleyev later said that in comparing elements and atomic weights, as he had noted them down on cards pinned to his laboratory wall, he had concluded that "the properties of elements depend in a periodic fashion on their atomic weights."

He added: "Even if I had some doubt concerning many obscure points, I had no doubt at all concerning the general character of the conclusion, since to admit that the relationships were purely coincidental was out of the question."

Mendeleyev finally outlined his new thesis in a paper which he presented to a meeting of the Russian Chemical Society on March 1, 1869. Today his triumph is attested in every chemistry laboratory in the world: hanging in colour on the wall is his enduring handiwork—the periodic Table of Elements.

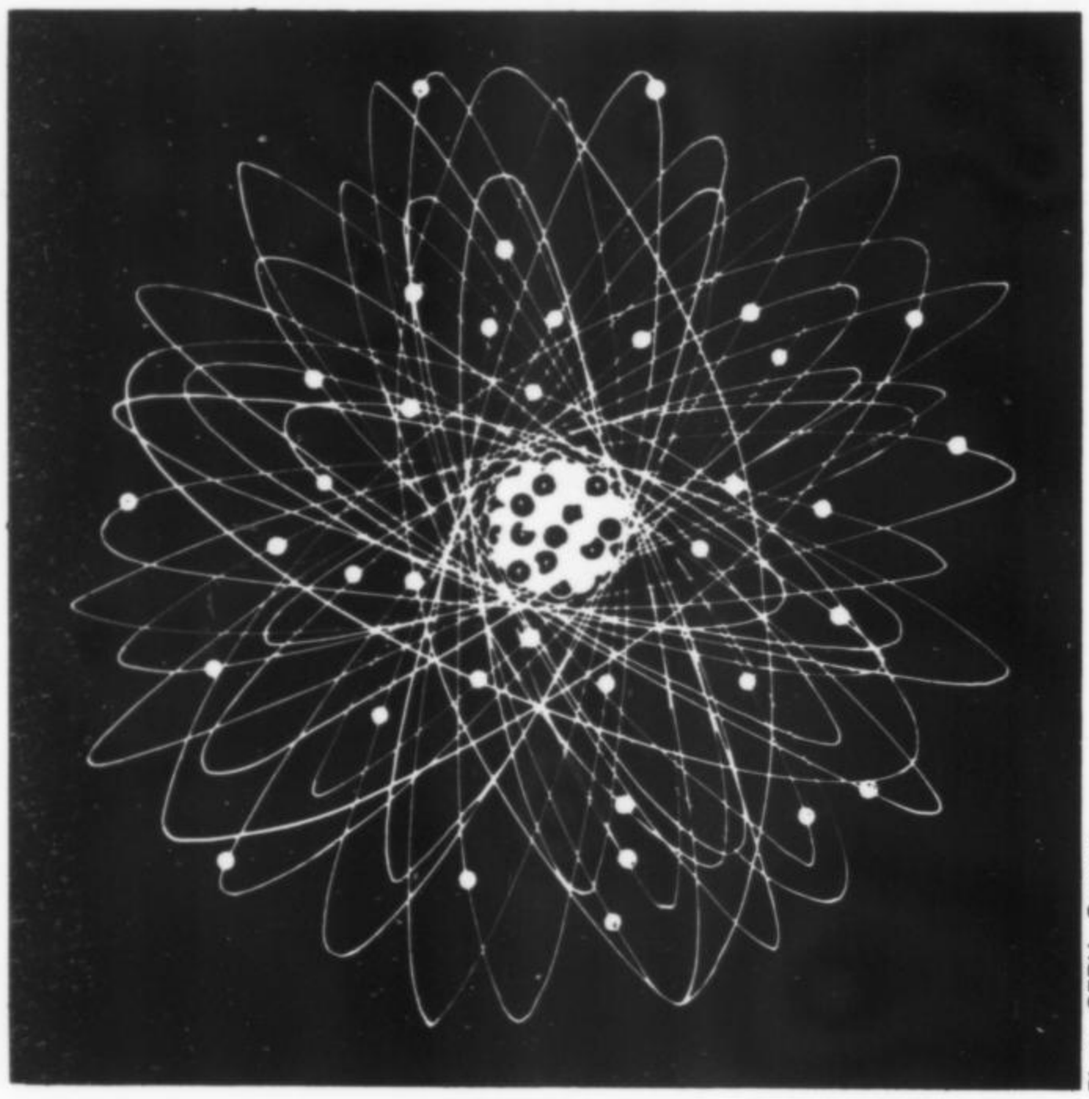


Photo CERN, Geneva

PLEXIGLAS SPIDER

Below, "plexiglas spider" enables nuclear physicists to see atomic particles as infinitely brief flashes of light. The apparatus is part of the detection equipment at the receiving end of a giant particle accelerator at CERN (the European Organization for Nuclear Research) near Geneva (See "Unesco Courier", March, 1966). Above, a simplified view of an atom, in this case of uranium. Negatively charged electrons orbit in planetary fashion around the nucleus composed of protons (positively charged) and neutrons (electrically neutral particles). Though physicists nowadays view atomic structures as more complex arrangements (resembling balls of energetic and uncertain "fluff") the image of the atom as a minute solar system is still a useful one for the non-specialist.

Photo © Jean Collombet, Meyrin, Switzerland

'Chance favours only the prepared mind'

—*Pasteur*

such as this and the "equivalent weight" concept of another English scientist, William Wollaston, were to pave the way for chemists later to perceive a cohesive order among all the elements found in nature. But until Mendeleyev's time, even the notions of what constituted an element were vague and subject to individual interpretation.

By 1850, an additional thirty elements had been recognized, bringing the total known to somewhat more than sixty. Tables of chemical order were offered by scientific thinkers such as Johann Döbereiner, Leopold Gmelin, E. Lennsen, Max von Pettenkofer, Jean-Baptiste Dumas, Willard Gibbs and John Gladstone—to name but a few.

In 1817 Döbereiner's "triads," or groups of three, had been an attempt to correlate trios of elements according to neighbouring atomic weights. By 1852, Gmelin had adapted the triads to four-and five-element series (tetrads and pentads), ranged according to their atomic weights, in increasing order.

Among the researchers whom Dimitri Mendeleyev was later to single out as most influential on his work were the French scientists Dumas and Lennsen. Dumas' contribution had been a method to calculate the atomic weight of elements within a given group, whereas Lennsen's was a first attempt to interpolate the atomic weights of elements yet to be discovered.

During the 1860s, novel forms of classifying the elements were proposed. One of these was Alexandre Beguyer de Chancourtois' "telluric screw," a spiral arrangement wound round an imaginary cylinder. It strikes today's reader as curiously parallel to the "double helix" in modern genetic chemistry.

In another view held at that time by John Newlands of England, every eighth element in the ascending order of atomic weights repeated certain characteristics. This was called the theory of octaves, after the layout of the diatonic scale in western musical forms.

Probably the most provocative of the new ideas was that advanced by a German scientist, Lothar Meyer. In 1864 Meyer published a table listing forty-four of the sixty-two known elements, arranged according to their "valency" instead of atomic weight.

XUM

No longer of significance today, valence refers to the combining power of one atom of an element: in water, or H_2O, the valence of oxygen is two because one of its atoms can join with two others (in this case, two atoms of hydrogen). And the valence of hydrogen was the point of departure in Meyer's first table. A later table proposed by Meyer was to be based on atomic weights.

These endeavours and those of three scientists, William Odling, Gustavus Hinrichs and H. Baumhauer, were all steps in the right direction, even though a few men of learning considered them as little better than mental games. Some chemists viewed the correlation of properties of the elements grouped in triads, octaves or along a telluric spiral as nothing more than happenstance and therefore little better than superficial analogy. Even as Newlands was presenting a paper before Britain's prestigious Chemical Society he was asked, ironically, if it would not be possible to obtain the same results by arranging the elements in their alphabetical order!

What, then, was Mendeleyev's theory all about? Briefly, he proposed arranging the elements in lines and columns (also called "periods" and "groups") inside a rectangle, with their atomic weights rising in number from left to right along the same line, one line following the other down the page.

The columns were determined by elements possessing analogous properties—the same kind of combining oxide, for example. The fewest atoms of an element (R) combining with the fewest of oxygen (O) would appear in the first column, augmenting in combining proportions toward the seventh column.

SINCE only some sixty elements were then known, eight columns sufficed then and still do today. In fact, the lay-out of an entire system still in use was prescribed by Mendeleyev when only slightly more than half its components were known.

Mendeleyev knew from the outset that he had developed a scientific device to lay out the chemical elements in a convenient system. More than that, he realized he had discovered an objective, natural law. Yet just as Newton had been popularly said to understand universal gravitation when struck on the head by a falling apple (or Watt realized that a boiling kettle could be transformed into the steam engine), there were still those who thought that Mendeleyev had come upon the periodic law . . . as the result of a dream.

Man tends to overlook that while scientific truth may suddenly strike one man's mind as a flash of lightning, that same scientist may have spent years of arduous research on his subject. Indeed, it was Pasteur who later commented that "chance favours only the prepared mind." If we take a look at Mendeleyev's activities before 1869, it becomes fairly clear that the emergence of the periodic table was no mere accident.

Although Mendeleyev's table was considered by some scientists as simply another in an endless series of dubious hypotheses, one of its great merits was its boldness. The progress made in chemistry during the past century has proved Mendeleyev's theory to be correct on two additional counts. He said that new elements would be discovered to help fill the holes in the system he had devised, and that the atomic weights of some elements which did not fit into his table had been calculated erroneously.

In the latter case (concerning the atomic weights of the elements cerium, indium, titanium, uranium, yttrium and others), Mendeleyev was soon to be proved right as new research helped rectify weights which were incorrect. Where an element did not seem to fit (such as uranium with an atomic weight of 116), he speculated on the true value. He arbitrarily doubled, for instance, the weight of uranium to 232; today we know the actual weight of that element to be 238.04.

In the other and more important case—the gaps in the periodic table—Mendeleyev was to see three new elements identified and described within sixteen years of his epoch-making declaration before the assembly of Russian chemists. Among the elements he had foreseen are those at first called eka-aluminium, eka-boron and eka-silicon ("eka" means "one" in Sanskrit); they were later renamed to honour the countries where their discoveries had occurred.

Eka-aluminium, identified scientifically in 1875 by the Frenchman Paul-Emile Lecoq de Boisbaudran, became known as gallium (atomic weight 69.72). Gallium thus filled the "hole" in the table between aluminium and indium.

Eka-boron, which Mendeleyev had predicted would have.an atomic weight midway between those of calcium and titanium (40 and 48), emerged in 1879 as scandium, honouring its Swedish discoverer Lars Frederick Nilson. The

CONTINUED PAGE 32

Unesco bibliography on science and technology

Unesco has just published an **Annotated Bibliography of Books and Materials on Science and Technology** designed for the general lay reader. Copies can be obtained free of charge by writing to the Division of Science Teaching, Unesco, Place de Fontenoy, Paris-7e. Note ! Supply limited.

The titles listed below are taken chiefly from the above Annotated Bibliography, which lists books in English and French.

The Structure of Matter by David Abbott, Piper Science Series, Pan, London 1966, 187 pp., 25p.

An Outline of Polymer Chemistry by James Allen, Contemporary Science Paperbacks No.25 Oliver and Boyd, Edinburgh, 1968, 125 pp., 38p.

Chemical Evolution: Molecular Evolution towards the Origin of Living Systems on Earth and Elsewhere by Melvin Calvin, Oxford University Press, New York, 288 pp., £1.25.

Aspects of Analytical Chemistry by R. A. Chalmers, Contemporary Science Paperbacks No.19, Oliver and Boyd, Edinburgh 1967, 144 pp., 38p.

Taking Charge by David Evans, Yardsticks of Science Series, Andre Deutsch, London 1970, £1.05.

Introduction to Chemistry by Peter Farago, Butterworth, Newnes, London 1965, 200 pp., 75p.

Organic Chemistry Today by F. W. Gibbs, "Pelicans" Penguin Books Ltd., Middlesex, 35p.

Chemistry by Kenneth Hutton, "Pelicans", Penguin Books Ltd., Middlesex, 40p.

An Approach to Chemistry by F. de Korosy, Pitman, London, 1969, 516 pp., £5.

Chemical Exchanges in Man by Bryan Matthews, Contemporary Science Paperbacks No.10, Oliver and Boyd, Edinburgh, 1967, 136 pp., 38p.

The Chemistry of Life by Joseph Needham (editor), Cambridge University, 1970, 240 pp., £3.

The Shape of Molecules by David Rees, Contemporary Science Paperbacks No.14, Oliver and Boyd, Edinburgh, 1967, 136 pp., 38p.

Chemicals from Petroleum by A. L. Waddams, Murray, London, 1969, £1.50.

Giant Molecules by Herman F. Mark, Life Science Library, 1965, 200 pp., $7.20.

Matter by Ralph E. Lapp, Life Science Library, 1969, 200 pp., $7.20.

A Guide to Science and Index to the Life Science Library by the Editors of Life, 1967, 200 pp., $7.20.

Understanding Chemistry by Lawrence P. Lessing, Harrap 1961.

The Story of Chemistry by Bernard Jaffe, Fawcett, Greenwich, Conn., U.S.A., 1948.

A Short History of Chemistry by James R. Partington, Harper, 1960.

SCIENCE'S HUNT FOR THE MISSING LINKS OF NATURE

by Vitali Goldanski

THE discovery of the Periodic Law, one of the fundamental laws of nature, by Dmitri Ivanovich Mendeleyev, has changed chemistry from a vast, chaotic conglomeration of facts into a strictly systematic and orderly science.

Today it would be unthinkable to try to teach or understand chemistry without the Periodic Law. The periodic change of chemical properties of elements and their classification in groups and periods has become the scientific basis of all analytical chemistry and is widely used in chemical technology. Mendeleyev's law is the basis of modern structural chemistry.

One example of the profound effect of the laws discovered by Mendeleyev on physical chemistry is the use of the Periodic System to select the most effective catalysts for chemical processes. For a long time, organic chemistry, based on the classic works of Alexander Butlerov in Russia and August Kekule in Germany, remained the least affected by Mendeleyev's discovery. However, the fundamental role of the Periodic Law became fully apparent in the formation and development of the chemistry of organometallic compounds, a new discipline on the boundaries of organic and inorganic chemistry.

The importance of Mendeleyev's discovery, however, is not restricted to chemistry; it has extended far beyond it to many allied sciences and primarily to physics. It can be claimed with full justification that, when interpreted and applied to physics, Mendeleyev's system became a succinct, clear cut, physico-chemical encyclopaedia, the quintessence of contemporary notions of the structure of matter.

The link between modern 20th century physics and chemistry, along the road mapped out by the Periodic Law, is more than simply the blurring of the division between the two disciplines; each reinforces and enhances the other. Their inter-relationship provides a specially striking feedback effect.

On the one hand, Medeleyev's discovery and the way in which he moved towards it contributed to the discovery of the complexity of the atom, to the emergence and advancement of nuclear physics, the systematic classification of the properties of nuclei and elementary particles and to other important achievements of physics.

On the other hand, the discovery and study of radioactivity, the successes of atomic—and later nuclear—physics led to an understanding of the meaning of an element's number in the System, to an understanding of the causes of the periodicity of the chemical properties of elements, to the filling in of the blank spaces in the Periodic Table and its extension far beyond uranium.

By proving the periodic alternation of the properties of elements depending on their atomic weights, Mendeleyev's law revealed the inter-relationship of all the atoms on our planet. It enabled scientists to tackle the question of atomic structure and eventually to approach the discovery of the atomic nucleus.

Mendeleyev himself thought that atoms would inevitably be proved to be complex structures. "One can readily assume, though as yet there

CONTINUED, PAGE 30

VITALI GOLDANSKI *is corresponding member of the U.S.S.R. Academy of Sciences and head of the Nuclear and Radiation Chemistry Laboratory of the Academy's Institute of Chemical Physics. A collaborator of Nicolai Semyonov, the 1956 Nobel prizewinner for physics, he is editor-in-chief of the journal "High Energy Chemistry", published in Moscow. Dr. Goldanski, 48 years of age, has written widely in the fields of physics and chemistry and his studies and articles have been published in many countries.*

XUM

"Atom smashers", or particle accelerators as they are known to the scientist, are today an indispensable tool for nuclear physicists everywhere in studying the world of the infinitely small. Photo shows giant accelerator at Serpukov, U.S.S.R.

Photo © APN, Moscow

KUM

Curium (96), Einsteinium (99), Fermium (100)...

is no means of proving it," he wrote, "that the atoms of simple bodies are themselves complex entities formed by the compounding of certain smaller parts; that what we call indivisible, the atom, is merely indivisible by conventional chemical means, just as particles are indivisible in normal conditions by physical means... The periodic dependency between properties and weight I have suggested evidently confirms such a presentiment."

Scientists worked for many years to discover the nature of the particles of which atoms are constructed. By the turn of the century it became apparent that the atoms of all elements contain electrons—negatively charged particles whose mass is about 1/1840th that of the lightest atom, hydrogen.

For a long time nothing was known about the carriers of positive atomic electricity, and the first atomic model, suggested by the English physicist, Sir Joseph Thompson, assumed that the whole volume of the atom was uniformly filled with a positive charge.

In 1911, another British physicist, Lord Rutherford proved that the whole positive charge of the atom, and almost all of its mass, was concentrated in the nucleus, the diameter of which was approximately 10,000 times smaller than that of the whole atom.

This discovery, and the subsequent investigations of the X-Ray spectra by Rutherford's young collaborator, Henry Moseley, led to the discovery of the physical meaning of an element's atomic number as denoting the magnitude of the positive charge of the nucleus of its atom. Thus, the carrier of the unit charge is the proton, nucleus of the lightest element, hydrogen. The number of protons in the nuclei of the atom of any other element equals the number of the square occupied by that element in the Mendeleyev system.

With the discovery of the nucleus, prominence was given to the planetary model of the atom according to which the nucleus is at the centre, like the sun in a planetary system, with the electrons revolving around it like planets; in a neutral atom the number of electrons is equal to the number of protons in the nucleus.

Niels Bohr, the Danish physicist, developed this concept of atomic structure and linked it with the quantum theory which had introduced into physics, at the turn of the century, the concept that a body does not radiate energy continuously but rather intermittently. After analyzing the structure of the Mendeleyev System, Bohr concluded, in particular, that the Sixth Period of the System must comprise 32 elements and that element No 72, then unknown, must be an analogue of zirconium.

Sure enough, a search for this element, carred out at Bohr's suggestion in zirconium ores, led to the discovery of hafnium (the missing element 72). Application of Bohr's theory to the Periodic System also led to the discovery of the 75th element, rhenium. Again and again the Periodic Law enabled scientists to describe the properties of undiscovered elements and to suggest ways of searching for them.

Perhaps the most important consequence of combining the Periodic System with the quantum theory was Wolfgang Pauli's "exclusion principle," advanced in 1925. After analyzing the Periodic Law in terms of quantum mechanics, Pauli concluded that an atom cannot contain two or more electrons in the same energy states.

Subsequently, the principle became the basis for a host of hypotheses and theories including those of atomic and nuclear structure, metals and semiconductors, super-conductivity, superfluidity and weak nuclear interactions, and for predicting the existence of anti-particles.

THE Mendeleyev System played a decisive part in the isolation and identification of the transuranium elements (those having an atomic number greater than that of uranium). The greatest contribution towards the production and study of these elements was made by the team of American scientists from the Lawrence Radiation Laboratory at Berkeley, California, headed by Glenn Seaborg. In particular they were the first to produce element 94, plutonium, whose properties are better known today than those of many "older" elements.

The achievement of the California team has resulted in the perpetuation in the Periodic Table of the great names of Marie and Pierre Curie (element 96, curium), Albert Einstein (element 99, einsteinium), Enrico Fermi (element 100, fermium). The Berkeley scientists gave the first element of the second hundred the name of Dmitri Mendeleyev (element 101, mendelevium), "in recognition of the pioneering rôle of the great Russian chemist, who was the first to use the periodic system of the elements to predict the chemical properties of undiscovered elements, a principle which has been the key to the discovery of many new elements."

In recent years, the laboratory directed by U.S.S.R. Academician Georgi Flerov at the Joint Nuclear Research Institute in Dubna has become a major centre of work on transuranium elements. In particular, the Institute has produced many isotopes of the later actinides (actinides are the group of elements with atomic numbers from 89 to 103), and has pioneered the synthesis of transactinide elements. The first element in the transactinide series, No. 104, was named kurchatovium in honour of Academician Igor Kurchatov, founder of the Soviet school of nuclear science.

For a long time the question of the chemical properties of elements lying farther away from uranium in the Periodic Table seemed to be a purely academic one since their isotopes decay very rapidly. Lately, however, more promising prospects of synthesizing very heavy elements have emerged. There is reason to hope that atomic nuclei containing about 114 or about 126 protons and approximately 184 neutrons will be found to possess greater stability.

The task of producing these elements artificially or searching for them in nature has become very relevant. Scientists at the Dubna Institute and elsewhere are at present hunting for element No. 114 which, according to the Periodic Law, should be eka-lead. As for element 126, this should logically belong to the 8th period of the System.

In our view, based on the work of the Soviet scientist V. M. Klechkovski, this period should theoretically contain 50 elements (though they may not all necessarily be synthesized), including a group of 18 hitherto unknown chemical twins, the octadecanides (elements 121 to 138). Their closest chemical analogue among known elements should logically be actinium.

Whereas the heavy elements mentioned above are almost 300 times heavier than hydrogen, examples of "new atoms" that are many times lighter than hydrogen are already known. In various "new atoms" the component particles of conventional atoms—protons and electrons—are replaced by other similarly charged elementary particles; today the number

YIN YANG

Following the discovery in 1932 by Dr. Carl Anderson of a positively charged electron, known as a positron, scientists have speculated that, in conformity with the essential symmetry of nuclear physics, every particle has its equivalent anti-particle. For reasons as yet not understood, when a positron meets an electron both particles are annihilated and energy is released. If anti-matter, composed of anti-particles, exists, physicists presume that were such anti-matter to encounter a piece of ordinary matter a catastrophic mutual annihilation would result. It is interesting to note that in 1957 the Nobel prize for research in this field of physics went to Tsung Dao Lee and Chen Ning Yang from China where the Yin Yang theory of complementarity has existed for thousands of years. Right, an example of the symmetrical paintings of the Dutch artist M.C. Escher seems curiously to symbolize the physicists' hypotheses.

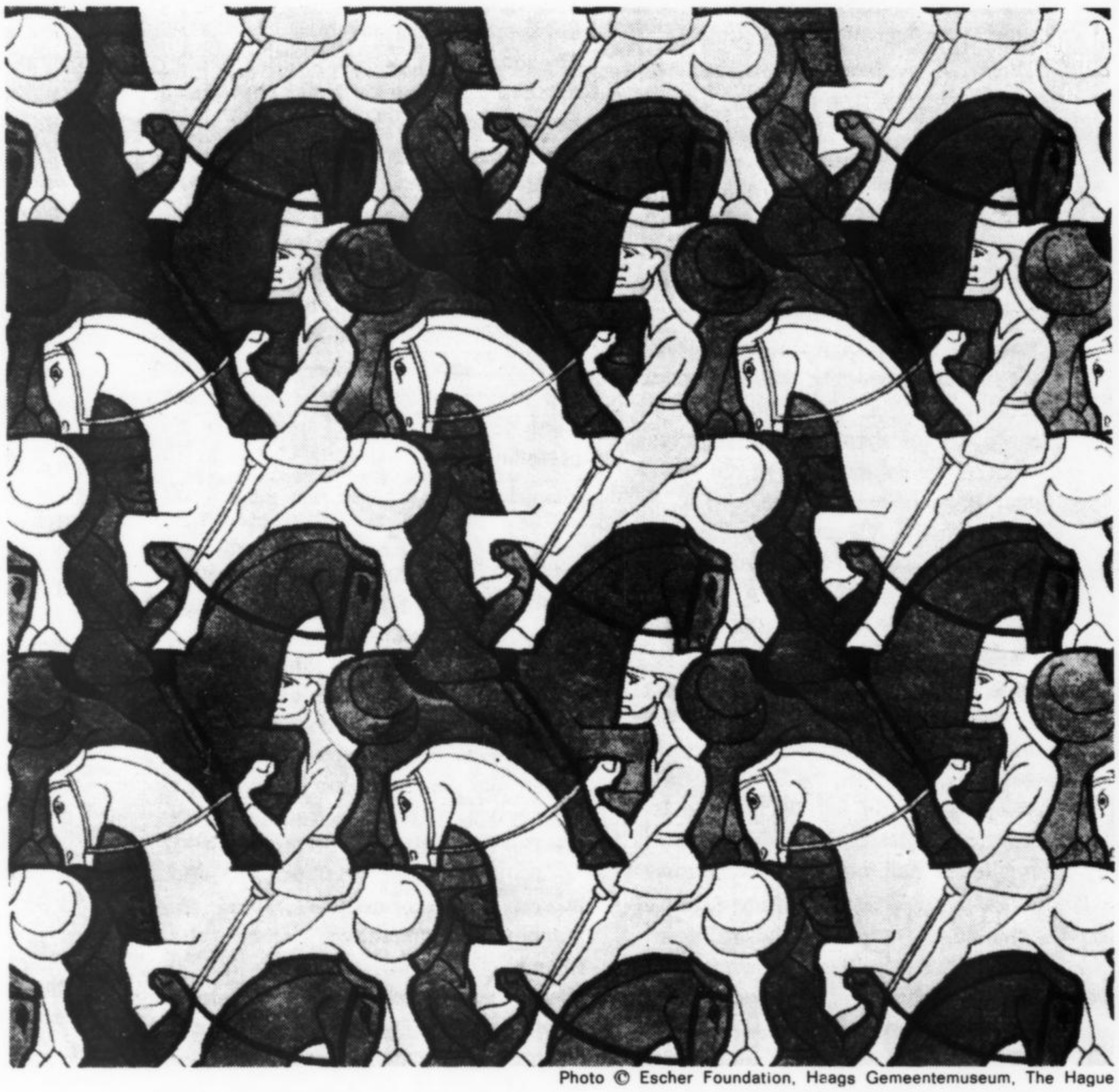


Photo © Escher Foundation, Haags Gemeentemuseum, The Hague

of known elementary particles runs into dozens. Various combinations of them can, in principle, yield hundreds of different new atoms.

This, of course, does not mean that the Periodic System is in need of enlargement or modification, since the substitution of some other negative particles for the electron does not change the charge of the nucleus, which determines an element's place in the Periodic Table, and the substitution of other positive particles for the proton yields atoms which in the chemical sense can be regarded as isotopes of hydrogen.

A short description of the chemistry of new atoms could begin with such newcomers to the first square in the Periodic Table as positronium and muonium. Positronium, which was discovered in 1951 by Martin Deutsch of the United States, marked the beginning of the history of new atoms. The difference between positronium and an ordinary hydrogen atom is that the proton is replaced by a positron, the anti-particle of an electron. Muonium is an atom of hydrogen in which the place of the proton is taken by a positively charged mu-meson particle.

Practically all the classes of chemical reactions of positronium have been studied in the last few years at the U.S.S.R. Academy of Sciences' Institute of Chemical Physics.

A comparison of the various reactions of atoms of positronium and hydrogen suggests that, although they have certain common chemical properties, their behaviour differs due to their great disparity in mass or atomic weight, in line with Mendeleyev's initial approach to the periodicity of chemical properties. It is this link with the Periodic System that gives special interest to investigations of the physical chemistry of the positron and positronium.

Mendeleyev's systematic ordering of known data and use of them to establish the existence of new, as yet unknown, entities and to predict their properties, recently found new expression in the system of elementary particles proposed by the American physicist, 1969 Nobel prizewinner Murray Gell-Mann. This system was brilliantly confirmed by the discovery of new particles whose properties agreed completely with his predictions.

The examples given amply demonstrate the fundamental role played by the Periodic Law even in entirely new spheres of science, which appeared decades after it was discovered. There can be no doubt that many new and striking pages of science of the future will be firmly linked with the great creation of Dmitri Mendeleyev. ■

THAT CHART ON THE LABORATORY WALL *(Continued from page 27)*

definitive atomic weight of this element, 44.956, was not established until 1955.

The third element, the so-called eka-silicon, became germanium on its discovery in 1886. Possessing an atomic weight of 72.59 and properties very close to those predicted by Mendeleyev, germanium was identified by Clemens Alexander Winkler, professor of chemistry at the Freiburg School of Mines, in Germany.

Besides being an excellent theorist, Mendeleyev proved to be a practical man. Before his death in 1907, he was to make chemical investigations of the oil fields at Baku in his native Russia and in Pennsylvania, U.S.A., as well as of the Caucasian springs of naphtha, a paraffin-like hydrocarbon mixture. (Hydrocarbons are chemical compounds consisting of carbon and hydrogen only.)

Long after his death, two more chemical elements whose existence was foretold by Mendeleyev were to be clearly identified. In 1925 the German husband-wife team of Walter and Ida Noddack isolated rhenium, which Mendeleyev had called bi-manganese.

A hard, grey metal often used in thermocouples, rhenium has an atomic weight of 186.20. Then, seventy years after Mendeleyev's discovery, Prof. Marguerite Perey, the distinguished French woman scientist, identified eka-cesium (renamed francium), at the Institut du Radium in Paris. Francium's atomic number is 87.

ON the heels of the discovery of the periodic law of the elements came one of the scientifically sensational findings of the late 19th century, that of the "inert" gas argon. This was the work of both Sir William Ramsay and Lord Rayleigh. The former had suggested to Rayleigh in 1894, after careful experimentation, that "... there is room for gaseous elements at the end of the first column of the periodic table." The two chemists announced the new gas later at a meeting in Oxford. We now know that argon and similar gases are not inert, but can combine with other elements.

Mendeleyev had not foreseen the inert gases simply because of their predominant "quality" of inactivity. Two years later (1896) Ramsay in England, and the Swedish chemist Per Theodor Cleve, working independently, discovered helium. The behaviour of helium (from the Greek word for "sun") had been observed spectroscopically for several years as one of the components of the solar atmosphere.

Based on Mendeleyev's reasoning, Ramsay was convinced that other similar gases existed. In 1898 he and Morris Travers identified three additional "inert" gases—neon, xenon and krypton. This family of elements came to form the "O" column of the periodic table.

IN that same year, 1898, Pierre Curie and his Polish wife Maria Sklodowska identified the phenomenon of radioactivity, which shattered one of the foundations of Mendeleyev's law —the invariability of the atom. Yet Mendeleyev could see no anomaly between his law and the existence of radioactive elements when he visited the Curies' Parisian laboratory in 1902.

Ten years later and after Mendeleyev's death, however, when the number of radioactive elements had risen to 37, scientists had some doubts about the adaptability of the periodic system. They wondered if Mendeleyev's arrangement could be considered valid if, as it appeared, there were no room on his table for the newly discovered elements.

It was in 1913, on the eve of the world's eruption into general war, that another modification clearly became necessary in the relationship between an element's structure and its position on the periodic table. Henry Moseley, a 25-years-old British physicist, had analyzed the X-ray spectra of fifty-one elements. He observed that there was a relation between an element's atomic number and the frequency of the X-rays it emits if bombarded by cathode rays. (An element's atomic number refers to how many electrons rotate about the nucleus of one of its atoms.)

As a result of the work of this brilliant young man (killed while on active service at the Dardanelles in 1915), seven more unfilled spaces on the periodic table were to gain new occupants. Besides the rhenium and francium already cited, these new elements were technetium, promethium, hafnium, astatine and protactinium. The uncovering of these new elements, found in effect by a technique which Mendeleyev could not have known, in no way disrupted the original disposition of the elements on his table.

Shortly after Moseley's discovery, another Englishman, Frederick Soddy, introduced the notion of isotopes (from the Greek for "same places"). The isotopes of an element possess all the same chemical properties. Their physical properties are identical in every respect except that of the weight or "mass" of the atom. Most of the mass is situated in the atom's nucleus, consisting of the proton carrying a positive electrical charge and the electrically neutral neutron. (The negatively charged "cloud" of planetary electrons consists of particles each having a mass of about 1/1,836 the mass of the proton.)

SODDY demonstrated, as did the Polish chemist Kasimir Fajans in that same year, 1913, that as an element disintegrates through radioactivity, the new position it occupies on the periodic chart depends on the kind of radiation it gives off. Alpha-disintegration (decay through the loss of alpha-particles) moves an element *two* spaces to the *left* on the table, whereas beta-disintegration of electron emission moves the element *one* space to the *right*.

It is true that there were some anomalies in the method of aligning the elements as at first suggested by Mendeleyev. In a few cases he had listed slightly heavier elements before somewhat lighter ones. Tellurium (127.6) was placed before iodine (126.9), cobalt (58.9) ahead of nickel (58.7), and thorium (232.0) came before protactinium (231.0).

After the standard of atomic *numbers* had been adopted, it was observed that if the elements were classified according to their nuclear electrical charges, their positions on the periodic table were just as Mendeleyev had predicted. It is in this form that chemistry students today are familiar with "that chart on the laboratory wall." ■

Letters to the Editor

THE EAGLE IN MYTHOLOGY

Sir,

May I make two observations concerning the interesting article by Patrocinio de Souza, "The Eagle—Spacecraft of the pre-scientific Age", concerning the symbolism of this bird in mythology and legends, published in your June 1970 issue.

In 1799, a hoard of 23 gold vases, dating from the 9th to the 11th century, was found at Sinnicolau Mare in western Romania. The origin of these vases, now in the History of Art Museum, Vienna, has long been the subject of discussion; were they Bulgarian, Hungarian or Patzinak (the Mongolian people that settled to the north of the Black Sea during the 9th century)?

The vases bear decorative elements in the style of the Persian art of the Sassanian era together with traces of Byzantine influence. On one of them (above left) a naked woman perhaps the goddess Venus, or the ancient Sassanian goddess of fertility Anahit, wearing a necklace, is being borne heavenwards in an eagle's claws; in her hands the woman holds two stylized flowers. On another vase (right) are two representations of a man (probably Ganymede, cup-bearer of the god Zeus) being carried away by an eagle with spread wings; he too wears a necklace and in his right hand is a vessel of some kind which he is holding out towards the eagle's beak; in his left hand he has a stylized plant.

Romanian folklore includes myths of the eagle carrying heroes and other personages up into the sky. One tale tells of a young princess carried off by an eagle to his eyrie at the top of a tree so high that it reaches the sky. In another Wallachian tale, an eagle carries away a young girl born from the thigh of an old man who had eaten an apple given him by *Sfinta Vineri* (otherwise known as "Saint Friday", a character who appears in many Romanian legends—"Vineri" or "Friday" derives from the Latin "Veneris Dies", "the Day of Venus"). In other legends, the hero, who has ventured into the "other world of dragons", is saved by the eagle who brings him back to earth.

Mihai Barbulescu
Institute of History and Archaeology
of the Academy, Cluj, Romania

PHILIPPINE NATIONAL HERO

Sir,

My wife and I have read the "Unesco Courier" for some years with great interest, but as far as I am aware you have never published an article on José Rizal, the national hero of the Philippines, a man of great talent, wide interests and considerable personal courage.

Doctor of Medicine and Philosophy, he was a gifted linguist with a knowledge of some 22 languages. His best known works are "Noli Me Tangere" and "El Filibusterismo". These describe life in the Philippines under Spanish rule. His writing eventually led to his execution on December 30, 1896. This day is now remembered as the Philippine National Day. He was also a sculptor and poet and is remembered for the very moving poem "My Last Farewell" written in his last few hours.

An article on this man—known as the Great Malay, the Pride of the Malay Race—could not fail to be of interest.

Harold Down
Dandenong, South Victoria
Australia

LOVE FOR CHILDREN

Sir,

You produce a very good magazine, but it lacks one very important subject —love for children.

I hope you will not be surprised to know that humanity, or at least an absolute majority of it, needs to learn how truly to love children.

Probably you would reason that love for children is a self-evident phenomenon or human feeling. To my mind this is not so. To love yourself in your children or to see your own interests in them, to marvel at them, does not imply a true love for children.

I think that if people everywhere learned to love the world's little ones, it would lead us much closer to a real and lasting Peace.

Ludmilla Skipenko
Maikop, U.S.S.R.

AUDIO-VISUAL AGGRESSION?

Sir,

That we are entering more and more the "culture of the image" is not in itself alarming, as long as the material transmitted by the modern media of mass communication remains truly cultural. What is disturbing is to witness a growing presentation of "images without ideas"—images that give birth to sub-standard culture or, worse still, to forms of anti-culture.

Experimental productions of the "LSD cinema", as screened by normal cinema and TV channels, may well be helpful to psychiatric and psychology students and researchers in studying the reactions of the public. But no reasoned and sensible educator would regard their public performance as justified or acceptable, particularly when we know that children will make up at least one third of the audience.

Psychedelic stimulants are no novelty. Their use for "scientific" experiments was attacked as long ago as 1939. Within a few years the public was horrified by revelations made at the Nuremberg Trial. These showed how audio-visual shocks coupled with other techniques for exerting pressure were used to destroy awareness of reality and the will to resist, and to inflict mental anguish. Such methods of creating psychic tension were called "torture". Today they go by other names to which modern modes and fashions have given a more aseptic tinge. But when all is said and done the traumatic effect is not so different. Perhaps the only difference is that in wartime they were practiced in the silence of prisons by the hands of torturers, whereas in time of peace, they are accepted by the public in daily doses prepared by the manipulators of audio-visual techniques.

J. Mallas Casas
Barcelona, Spain

NEGLECTED NOMADS

Sir,

I am conducting a project on the education of gypsy and travelling children for the Schools Council in London. Included in the study are children of nomad, itinerant and other migrant groups. The main purpose is to distribute knowledge and experience about the nature of such children and about methods of teaching and curriculum successful with them.

As it seems very much an international problem, I am appealing through the "Unesco Courier" to teachers and educational administrators also involved with these children to get in touch with me so that an international dialogue may be started. Such a dialogue can only be mutually beneficial and may help to raise the educational level of this most neglected group of children.

Christopher Reiss
West Midlands' College of Education
Gorway, Walsall, Staffs, U.K.

WORLD VIEW OF HISTORY

Sir,

Contrary to the viewpoint of Mr. A. Bénésis (Letters, March 1971), I feel that history teaching in the majority of schools in the different states tends to inculcate in children and citizens a distorted sense of nationalism.

I feel it is up to Unesco to make approaches to these states with a view to replacing such lessons by teaching based on a worldwide appreciation of history.

J.L. Boehler
Villé, France

WE ARE ALL GUILTY

Sir,

The United Nations has designated 1971 as International Year for Action to Combat Racism and Racial Discrimination, and in your February 1971 issue, His Holiness Pope Paul VI speaks of the growth of racial and religious discrimination and the menace it represents to world peace.

However, we should not only look at those few countries where discrimination is widespread and evident. Everybody can find traces of discrimination in his own milieu and everyone is guilty of some form of racial, group, religious or social discrimination.

We should not generalize the possible faults of a few members of a racial or social group, race or religion and project them to the whole group. We should not forget that man is made by his environment and our aim should be to do everything possible to improve that environment.

Gerard Mulder
Apeldoorn, Netherlands

BOOKSHELF

RECENT UNESCO BOOKS

■ **Readings in the Economics of Education**
A selection of articles, essays and texts on the relationships between economics and education. Editorial Advisory Board: Mary Jean Bowman, Michel Debeauvais, V.E. Komarov, John Vaizey
Composite English/French (articles in French are followed by an abstract in English)
1968 (3rd imp. 1971), 945 pp., £1.95, $6.50

■ **Education in the Arab Region viewed from the 1970 Marrakesh Conference**
By Mohammed A. El-Ghannam
(Educational Studies and Documents No. I, new series)
1971, 57 pp., 45p, $1.50

■ **Science Policy and the European States**
(Science Policy Studies and Documents, No. 25)
1971, 208 pp., 90p, $3.00

■ **Scientific Framework of World Water Balance**
A contribution to the International Hydrological Decade
(Technical Papers in Hydrology, No. 7) 1971, 27pp., 75p, $2.50

■ **Rural Mimeo Newspapers**
A guide to the production of low-cost community papers in developing countries
By Robert de T. Lawrence
(Reports and Papers on Mass Communication, No. 46). 1965 (3rd imp. 1971), 42 pp., 25 p, $0.75

■ **The Mass Media in a Violent World**
By Mary Burnet
(Reports and Papers on Mass Communications, No. 63)
1971), 42 pp., 25p, $0.75

★

OTHER BOOKS

■ **Science and Education in the 17th Century**
The Webster-Ward Debate
Edited by A.G. Debus
Elsevier, Amsterdam, The Netherlands, 1970, £6

■ **World Cultural Guides**
A new concept in guide books
Volumes now available on London, Paris, Rome, Venice
Thames and Hudson, London 1971, £3.25; Holt, Rinehart and Winston, New York, 1971, $9.95 (see item)

■ **The World Development Plan**
A Swedish Perspective
By Ernst Michanek
Almqvist and Wiksell, Stockholm
The Dag Hammarskjold Foundation
1971, $3.00

■ **Guidance in Comprehensive Schools**
A Study of Five Systems
By B.M. Moore
National Foundation for Educational Research in England and Wales, Slough, U.K., 1970, £1.40

UNESCO NEWSROOM

Romania presents neolithic vase to Unesco

Photo Unesco

A Neolothic vase from Romania has joined other works of art contributed by member states to decorate Unesco's headquarters in Paris. The 4,500 year-old painted vase was presented to Mr. René Maheu, Unesco's Director-General, by Ambassador Valentin Lipatti, Romanian Permanent Delegate to Unesco. Unearthed in the Jassy region of Romania, it is a typical work of the Coucouteni Neolithic culture which emerged nearly 5,000 years ago, and whose influence extended from Transylvania to the Dnieper plain.

World Cultural Guides

A series of guides to the major cities of the world has just been published which provides an authoritative history of each city's growth and full details of museums, art galleries, landmarks, etc. Each volume contains between 150 and 200 illustrations, in colour and black and white, designed to provide a visual history of the artistic heritage described in the text. An appendix on artists and architects guides the visitor to the works of any artist in whom he is interested. Volumes on London, Paris, Rome and Venice are already available and further volumes on Florence, New York and Madrid are to be published shortly (See Bookshelf.)

Fair Play Trophy for Polish cyclist

The Pierre de Coubertin International Fair Play Trophy for 1970 has been awarded to the Polish cyclist Ryszard Szurkowski. When his chief rival Zygmunt Hanusik had mechanical trouble in the Polish National Cycling Championship last year Szurkowski lent him his reserve bicycle, and Hanusik went on to take the Polish title. The award was made last month at Unesco's Paris H.Q., when a Diploma of Honour was also presented to the Tunisian basketball player Mohamed Senoussi for his services as a referee and the sportsmanship he has displayed throughout his career.

Harold J. Plenderleith receives Unesco award

Mr. Harold J. Plenderleith, who has just retired after 13 years as Director of the International Centre for the Study of the Preservation and Restoration of Cultural Property, in Rome, has been awarded the Unesco Silver Medal. Mr. Plenderleith, a former curator of the British Museum research laboratory, is an internationally famous pioneer in the use of modern scientific techniques for the restoration of ancient works of art. As the director of the Rome centre, set up in 1959 by Unesco and the Italian Government, he played a leading role in the restoration of cultural treasures damaged by the 1966 Florence floods. (See "Unesco Courier", January 1967).

Unesco-sponsored 'History of Africa'

The "General History of Africa", to be published under Unesco auspices, will comprise eight volumes, and will also appear in a paperback edition and an abridged version in a number of African languages. This was announced recently by the international committee of Africanists which is preparing the History—the most comprehensive work on Africa's past ever attempted. Work has begun on two volumes and it is planned to complete the set, to appear in English and French, by 1978.

Arts of Asia

A new magazine, "Arts of Asia", devotes its second issue (March-April, 1971) to Japan and in particular the 7th International Biennial Exhibition of Prints held in Tokyo. "Arts of Asia" is the first publication in East Asia to deal exclusively with the whole range of the arts, ancient and modern, of the Asian region. The first issue dealt with China and future numbers will focus on Burma, Thailand and Korea. "Arts of Asia", a bi-monthly, costs $7.50 per year, and can be ordered from. Arts of Asia, 1002 Metropole Building, 57 Peking Road, Kowloon, Hong Kong.

Self-disposing litter

A plastic packaging material that disintegrates after exposure to sunlight has been developed after seven years' research by scientists at the University of Toronto in Canada. The plastic breaks up after being exposed to ultra-violet rays for about a month, leaving only a small sand-like deposit. The discovery is one answer to the growing problem of pollution by indestructible synthetic packaging.

Flashes...

■ *The Republic of Yemen has imposed a special tax on postage stamps and cinema tickets to raise funds for a nation-wide drive against illiteracy.*

■ *As many as 100,000 persons are killed in industrial accidents each year, reports the International Labour Office.*

■ *The Council of Europe has called on those member states who have not yet ratified the U.N. Convention on the Elimination of All Forms of Racial Discrimination to do so in 1971—International Year to Combat Racism and Racial Discrimination.*

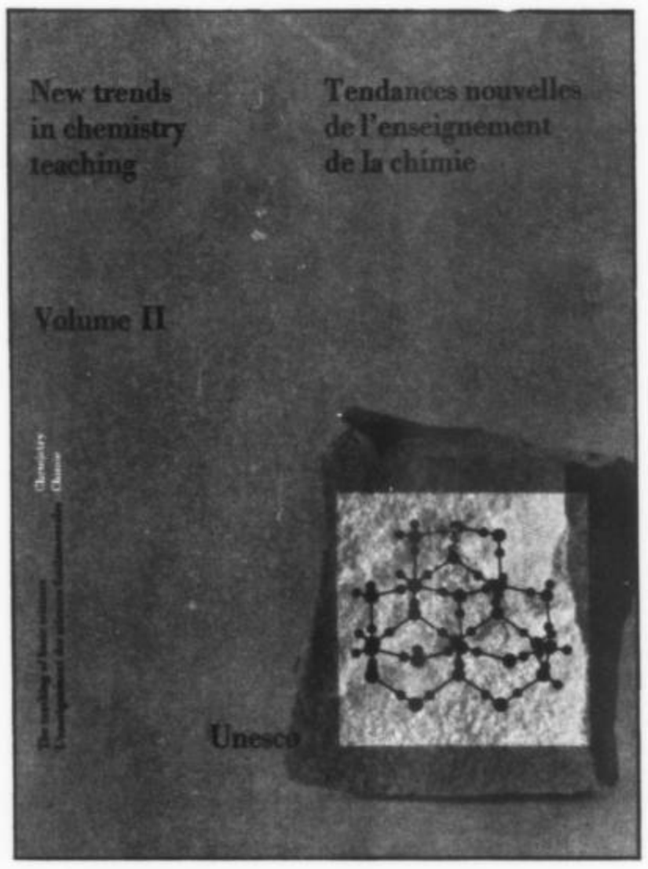
■ *Enrolment in Asia's secondary schools has doubled, from 17 million to nearly 36 million, since 1960.*

■ *The Rhine, one of the world's most polluted rivers, discharges 60 million tons of dissolved solids into the North Sea every year—about one ton for every person living in the Rhine basin.*

Imp. GEORGES LANG, PARIS. IMPRIMÉ EN FRANCE. — Dépôt légal. 2e trimestre 1971 - C 1

Published by Unesco

in the series "The Teaching of Basic Sciences"



New trends in chemistry teaching

- **Vol. I (1964-1965) 2nd imp. 1968, 359 pp, $7.00**
- **Vol. II (1969) 407 pp, $7.00**

An international presentation of articles from leading science-teaching journals on content, approaches and techniques in chemistry teaching.

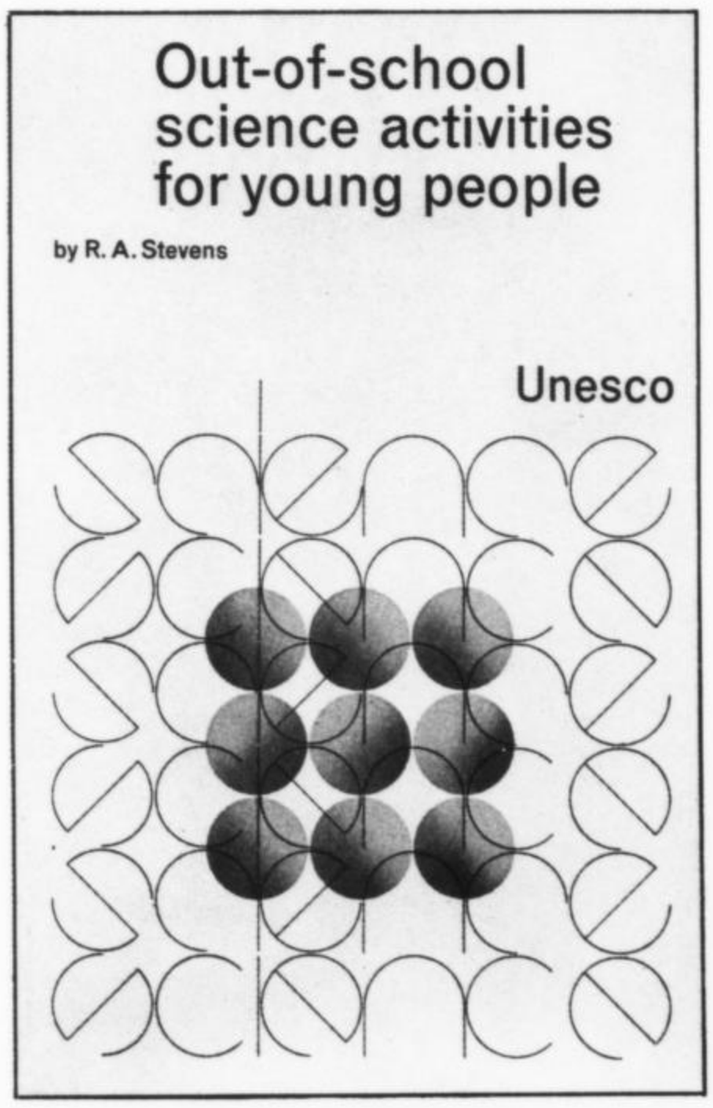
The series includes:

- **NEW TRENDS IN BIOLOGY TEACHING**
  Vol. I (1966) 2nd imp. 1968, 298 pp, $4.50
  Vol. II (1969) 368 pp. $5.00
- **NEW TRENDS IN PHYSICS TEACHING**
  Vol. I (1965-1966) 2nd imp. 1968, 271 pp, $6.50
- **NEW TRENDS IN MATHEMATICS TEACHING**
  Vol. I (1966) 2nd imp. 1968, 438 pp, $6.00
  Vol. II (1970) 476 pp, $7.00
- **A SURVEY OF THE TEACHING OF PHYSICS AT UNIVERSITIES**
  1966, 396 pp, cloth: $6.50

Just published:

NEW TRENDS IN INTEGRATED SCIENCE TEACHING
Vol. I $7.00

- **Presents a broad international picture of the scope and variety of science activities for young people**
- **Describes techniques and methods of promoting and providing opportunities for out-of-school science education: clubs, science fairs, camps, meetings, museums, nature conservation**



129 pages $2.00

Order from:

UNIPUB. INC. (UNESCO PUBLICATIONS CENTER) P.O. BOX 433, NEW YORK, N.Y. 10016

A ROOM WITH A VIEW — RIGHT THROUGH

Floor, ceiling, walls, chairs, tables made of transparent plastic give this futuristic room an ethereal, out-of-this-world quality. Modern polyester resins reinforced with fibre glass can be moulded to any shape required and with their great strength need no supporting framework. (Article page 4.)

Photo Ku Khanh © Quasar Engineering, Paris

XUM

MAXIMUM